TCRP
SYNTHESIS 41

TRANSIT
COOPERATIVE
RESEARCH
PROGRAM

Sponsored by
the Federal
Transit Administration

The Use of Small Buses in Transit Service

A Synthesis of Transit Practice

TRANSPORTATION RESEARCH BOARD

NATIONAL RESEARCH COUNCIL

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The Use of Small Buses in Transit Service

A Synthesis of Transit Practice

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SUBJECT AREAS
Public Transit

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TRANSPORTATION RESEARCH BOARD — NATIONAL RESEARCH COUNCIL

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of vice configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB), and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at anytime. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end-users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the Transit Development Corporation, the National Research Council, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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PREFACE

A vast storehouse of information exists on many subjects of concern to the transit industry. This information has resulted from research and from the successful application of solutions to problems by individuals or organizations. There is a continuing need to provide a systematic means for compiling this information and making it available to the entire transit community in a usable format. The Transit Cooperative Research Program includes a synthesis series designed to search for and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in subject areas of concern to the transit industry.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to transit agency professionals and the consultants who work with them in dealing with small buses in transit service. It offers responses from 94 public transit agencies in North America—how they were using small buses and their experiences with them. A summary of research findings gathered through surveys and site visits is presented. Results show that 58 percent of the respondents use small buses and, on average, small buses make up about 18 percent of their fleets. The focus in this document is on the use of small buses—30 ft or less in length, as replacements for large buses in fixed-route, scheduled service or those used in innovative, more flexible operations such as route deviation or demand-response service. At the onset, it was decided to exclude from study paratransit services that are available only to eligible customers, such as the elderly or people with disabilities. Additionally, rural service and services using trolley replicas were not included in the scope of the study.

Administrators, practitioners, and researchers are continually faced with issues or problems on which there is much information, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered or not readily available in the literature, and, as a consequence, in seeking solutions, full information on what has been learned about an issue or problem is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to the available methods of solving or alleviating the issue or problem. In an effort to correct this situation, the Transit Cooperative Research Program (TCRP) Synthesis Project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common transit issues and problems and synthesizing available information. The synthesis reports from this endeavor constitute a TCRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to a specific problem or closely related issues.

This document from the Transportation Research Board integrates information from several tasks. There is information included from a summary of research findings, documents, and websites and from survey responses from transit agencies in North America

that have been identified as using small buses, as well as those agencies identified as not using small buses. Also information is included from a survey of small bus manufacturers, follow-up communications with transit managers and staffs, and four detailed on-site case studies.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, available information was assembled from numerous sources, including a number of public transportation agencies. A topic panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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THE USE OF SMALL BUSES IN TRANSIT SERVICE

SUMMARY

This study explored the use of small buses in transit services, either as replacements for large buses in fixed-route scheduled service or in innovative, more flexible operations, such as route deviation or demand-response service. For the purposes of this study, small buses were defined as vehicles used in urban public transit services open to the general public that were 30 ft or less in length. At the onset of the study, it was decided to exclude paratransit services that are available only to eligible customers, such as the elderly or people with disabilities. In addition, the study did not include rural service and services using trolley replicas.

The study involved several tasks, including a survey of transit agencies in North America that had been identified as using small buses, a survey of transit agencies that had been identified as not using small buses, a survey of small bus manufacturers, reviews of documents and websites, follow-up communications with transit managers and staff, and four detailed on-site case studies.

Surveys were sent to American Public Transportation Association (APTA) and Canadian Urban Transit Association (CUTA) transit system members that *used* small buses in open services. Ninety-four transit agencies provided information on how they were using small buses and their experiences with small buses. These agencies operate over 19,000 buses in a broad range of urban settings, from small towns to large cities, and in the wide range of climate conditions found in the United States and Canada. A brief survey was sent to the APTA and CUTA system members identified as *not using* small buses in open services to obtain insight on the reasons why they did not use small buses. The results of these surveys are highlighted here.

- Approximately 58 percent of the transit system members of APTA and CUTA use small buses, and on the average, small buses make up approximately 18 percent of each fleet.

- There are a large variety of small buses available to transit agencies. Twenty-three small bus manufacturers were identified as marketing several different models of small buses to transit systems. The “User” survey respondents operate 57 different models of small buses.

- Eighty percent of survey respondents use small buses in fixed-route service, primarily as a replacement for large buses in areas and at times of low demand. Approximately 25 percent of respondents use small buses in circulators, demand-response service, or route deviation services. Approximately 12 percent use small buses in various forms of flexible feeder service.

- The two most important rationales cited for purchasing small buses were the ability to match capacity with demand and the higher maneuverability of small buses on narrow streets. Other important rationales were marketing image, lower capital costs, community complaints, and lower maintenance costs.

- Forty-four percent of survey respondents reported their overall experience with small buses as "very good," and only 15 percent reported their overall experience as "poor." The level of satisfaction varied directly with the number of small buses in the agency fleet, and indirectly with the size of its total fleet. The lowest levels of satisfaction were found in large transit agencies operating a relatively small proportion (10 percent or less) of their fleet with small buses.

- Vehicle reliability (42 percent) and high maintenance costs (53 percent) were the most frequently cited issues/concerns about the use of small buses. These problems were often associated with specific vehicle models. Customer and operator satisfaction and acceptance were issues also frequently cited (33 to 39 percent). Often, customer dissatisfaction was associated with ride quality and sometimes with overcrowding. These problems are further compounded when the small buses are operated in peak-hour service with overloading conditions.

- The continual change in small bus manufacturers and in model features, and even in names for similar models, are major sources of confusion for transit agencies. These changes make it difficult for transit managers to easily distinguish, through conversations with colleagues, the actual experience with respect to different models. This lack of communication, in turn, appears to lead to a general broad-brush negative image for small buses.

- The negotiating of a lower small bus wage rate significantly decreases the cost of operating small buses and increases their cost-effectiveness in the lower level demand routes and service areas typically found in suburban areas. Negotiating a lower small bus wage rate can be a lengthy process that could be considered over several successive contract negotiations.

- Case studies revealed how systems can use small buses in a wide range of service design concepts, aimed at very different market segments. Small bus-based services were found to be an important and integral component in a "Family of Services" overall strategy. In particular, small buses can provide a flexible and cost-effective tool in serving low-density suburbs, where auto-oriented land use and lack of pedestrian amenities make them difficult to serve with traditional linehaul transit using large buses.

The information gathered by means of the surveys and site visits resulted in the recommendations cited here.

- The most successful uses of small buses build on a more strategic approach to the planning of transit services. A comprehensive strategy should articulate the role of small buses and the markets they serve. Senior management needs to convey this strategy to the implementation stage, with a clear identification of responsibilities, careful selection of vehicles, and the development of appropriate operating procedures and monitoring systems. The introduction of small buses can be disruptive to an agency's operational routines and procedures that have been historically based on large buses. Senior management needs to continuously and clearly communicate the

significance of small buses to corporate strategy in order to overcome the inherent organizational inertia and resistance.

- To determine whether or not the strategic goals are being achieved, data collection and monitoring are critical. Appropriate performance metrics, data collection, and analysis systems are needed to monitor performance, cost-effectiveness, and complaints. Periodic market research on customer acceptance and concerns are critical in the early stages of implementation of innovative and experimental services.

- The potential for an agency to build a positive image with the use of small buses is enhanced when customers recognize that small bus services are different. Attention needs to be focused on the creative and consistent branding of small bus services for all customer information tools (printed schedules and maps, route nomenclature, bus paint schemes, stop design and information, website information, etc.).

- With the large variety of small buses available to transit agencies, it is important to make careful and thorough investigations of these choices before purchase. Access to a demonstrator vehicle would assist in determining customer, operator, and mechanic acceptance. A review of the Altoona Bus Testing Center reports on the buses under consideration is recommended prior to vehicle selection. In particular, discussions with any bus manufacturer regarding prospective design changes made to address any bus failures occurring during tests would be beneficial.

- Deployment of the vehicles should be realistic in terms of their actual passenger capacity. Small buses can play an important role, but cannot be expected to perform adequately if they are used in situations where demand exceeds their capacity. This should be recognized in the scheduling process, and route performance monitoring systems should be used to identify problems as soon as they occur.

The following two areas for future research were identified during the course of this study:

- Research is needed to better understand the cost-effectiveness of innovative small bus services. It should collect cost and ridership data for different types of small bus services, operated under different circumstances in terms of land-use and cost regimes (e.g., with and without a lower bus operator wage rate). Such a study would provide a better understanding of how these different factors affect the cost effectiveness of small bus applications in particular areas of low demand.

- Research is also needed to understand the complex labor-relations issues surrounding the negotiations of a small bus operator wage rate. Further research should explore different strategies that have been pursued in negotiating a small bus wage rate, and analyze different approaches to implementation.

CHAPTER ONE

INTRODUCTION

BACKGROUND

Early versions of the motor bus first made their appearance in the North American urban transit scene in the early 1920s. Typically 28 to 30 ft in length, powered by a gasoline internal combustion engine, and equipped with rubber tires, they initially represented only a minor adjunct to the electric street railways and subways that were the primary technology being used by the transit industry. However, bus technology evolved considerably over the next few decades, as did their use and importance to the transit industry. Electric street railways were systematically abandoned and converted to bus service across the continent. By the early 1960s, fixed-route service, provided using standard 40-ft (or 35-ft) diesel buses had become the norm for the entire industry; and by 1965, motor buses represented 80 percent of the total U.S. transit fleet. The only exception were the half dozen cities that still operated subway or streetcar service, and even in these cities, standard buses played a major role.

Over the last four decades, fixed-route service using 40-ft buses has remained the norm for the transit industry despite numerous technological developments made possible by federal funding in the United States and provincial subsidy support in Canada. For example, since 1970, more than a dozen North American cities have implemented new heavy or light rail services. In addition, various new technologies and service concepts were developed and tested during this period, including the monorail automated people movers, dial-a-ride, mag-lev, and guided bus. Despite these efforts, the 40-ft bus, operating on fixed-route service on streets and arterials, has remained the workhorse of the industry.

The evolutionary standardization that has occurred with the 40-ft bus has offered the industry several advantages.

- Technical Characteristics—The technical specifications of the urban bus have been considerably standardized over this period: first, with the "White Book" specifications in the late 1970s, and more recently with the American Public Transportation Association (APTA) Standard Bus Procurement Guidelines for the 35/40 Foot Heavy-Duty Transit Bus. These technical characteristics provide very acceptable technical performance and meet the requirements for operation on the streets and arterials of the vast majority of North American cities.

- Acceptable Capacity—Standard buses generally offer a reasonable capacity (seating capacities of about 43 passengers and standee loads of about 65 passengers) that has been more than adequate for most transit applications in North America. Rail-based technologies (heavy or light) have been implemented in specific corridors where the capacity offered by buses is insufficient.

- Reasonable Operating and Maintenance Costs—Heavy-duty diesel technology is a mature and reliable technology and is cost-effective when properly maintained. Diesel fuel-based technology requires little infrastructure, and the fuel cost remains extremely competitive compared with other fuels and alternative propulsion technologies.

- Standardized Parts Inventory—Standardizing a given technology offers additional potential advantages, because it may simplify and reduce parts inventory, tools and equipment, training, and maintenance operations.

- Enhancements to Standard Bus Technology—There have been some successful efforts to enhance bus technology in order to address some of its deficiencies. Low-floor buses, introduced in 1992 in North America, are increasingly being deployed by transit agencies and help enhance vehicle accessibility, in particular for seniors and persons with disabilities. In addition, considerable effort to develop lower emission alternative fuels or new propulsion technology continues, although to date none have managed to combine lower emissions at the equivalent or lower cost.

Although the traditional approach of using standard 40-ft buses on fixed-route service continues to dominate the industry, there has been a growing interest in, and use of, small buses (30-ft or less) in both fixed-route and more flexible or demand-response applications. According to the *APTA 2000 Public Transportation Fact Book* (*1*) there was a 112 percent growth in the number of 30-ft buses acquired annually, between 1988 and 1998; nearly twice the growth rate for new standard-size buses. In addition, these buses are being deployed in a variety of applications. In some cases, smaller buses replace standard buses on fixed-route service on lower demand routes. In other situations, they are deployed with flexible-route deviation or community

bus-type services. In still others, they are used for demand responsive services open to the public.

This growing interest in small buses is derived from a number of factors.

- Growing Suburbanization—The growth of the suburbs continues. A higher percentage of the U.S. population and employment is in the suburbs rather than in city core areas. Suburban land-use patterns, involving closed low-density subdivision design with circuitous street patterns, and strip commercial development along arterials, are notoriously difficult for traditional transit to serve cost-effectively. Many transit agencies have looked for innovative service design concepts, often involving the use of smaller buses to serve this standard-transit inhospitable land-use environment.

- Inaccessible Street Design—A corollary of the previous point is that street design in suburban subdivisions or shopping centers often does not take into consideration the physical requirements (e.g., turning radius, overhead clearance, etc.) that would enable standard transit buses to serve these neighborhoods and centers. The same applies to providing close access to certain facilities used by frequent transit patrons (senior homes, assisted-living facilities, hospitals, etc.). Small buses often offer greater flexibility in serving such areas.

- Noise and Vibration—Although 40-ft buses offer excellent capacity performance, they are nonetheless heavy-duty vehicles that generate complaints of noise and vibration from residents on narrow neighborhood streets. Some transit agencies have noted that noise and vibration problems have increased with the implementation of 40-ft low-floor buses.

- Perceived Image—Beyond specific complaints related to the physical characteristics of large buses, all transit agencies receive complaints from residents and government officials about the perceived cost and inappropriateness of operating standard-size buses in certain communities, especially in times or areas of low demand. This is often expressed as "the empty bus syndrome." It is a constant challenge to transit managers to address this perceived image problem.

- Cost-Effectiveness for Areas and Times of Lower Demand—The operation of smaller buses may offer cost savings over larger buses, although opinions in the industry vary widely on this issue. Lower operating costs would enable more cost-effective transit service and, in some cases, protect some form of transit service for areas or times of lower demand.

Whether in response to the access and mobility needs for ever-sprawling suburbs, small markets, and/or limited budgets, small buses seem to make sense to a growing number of transit professionals, the public, and community leaders. The purpose of this synthesis is, therefore, to explore the current use of small buses in today's transit industry, review the various applications of how small buses are used, and identify related issues.

SCOPE

The purpose of this study was to gather information on the use of small buses in transit service, whether as replacements for large buses in fixed-route service or in innovative, more flexible applications, such as route deviation or demand responsive service. However, it was decided at the outset of the project to exclude paratransit services that are exclusively available for eligible customers [i.e., Americans with Disabilities Act (ADA) service]. The defining criteria for those services to include in this study relate to whether the service was open to the general public.

In terms of the scope of vehicles under consideration for the purposes of this study, small buses were defined as vehicles used in public transit service that are 30 ft or less in length. This represents a very wide range of technological choice, including

- *Standard heavy-duty bus designs* from bus manufacturers that produce the 40-ft buses, whose length has been reduced by 10 ft, typically through the removal of a mid-section from the vehicle, and sometimes by removing the rear door. North American buses of this type are of an integral or semi-monocoque construction.

- *Body on medium-duty truck chassis designs* from small bus manufacturers that fabricate body shells to be installed on the truck chassis and complete the integration and assembly of other subsystems, such as seating, signage, wheelchair lifts, and heating and air-conditioning.

- *Cut-a-way vehicle designs with bodies on van or light-duty truck chassis*. In some designs the roof of a van is raised to accommodate a wheelchair lift and in other designs the manufacturer places a body on the chassis and integrates and assembles the subsystems as mentioned earlier. In addition, the recent arrival in North America of *body on bus chassis vehicles*, built by bus manufacturers, is apparent. This design approach, using a transit bus chassis as a basis, but with a body and final assembly by a separate company, is used extensively in Europe, but less often in North America.

- Over the last several years, some bus manufactures have introduced *new low-floor medium to heavy-duty small transit buses*. These designs are integral and semi-monocoque in design, and use subsystems similar to those used in the standard 40-ft buses.

APPROACH

The methodology used to prepare this synthesis involved the following several elements:

- Fleet data was collected from the APTA and the Canadian Urban Transit Association (CUTA). APTA's Vehicle Fleet Databases (*2*), for both conventional and demand responsive bus fleets, and CUTA's Annual Operating Data, were analyzed to identify those agencies that operate small buses in transit service.

- A survey of transit agencies using small buses was sent to all transit agencies in the United States and Canada that had reported operating small buses to APTA or CUTA The survey asked questions concerning the description of the transit agency, the types of services that used small buses, the primary reasons for implementing small buses, experience and issues, the existence of a differential wage rate for operating small buses, and the availability of pertinent information.

- An additional follow-up survey was conducted of those transit agencies with a differential wage rate for operating small buses to gather some additional information about such wage rates and any limitations on the number of operators in this category.

- A separate brief survey of transit agencies *not* using small buses was also prepared and sent to all agencies that do not operate small buses. It was believed that they might add some insight about the major perceived reasons and obstacles that limit the implementation of small buses.

- A survey was conducted of small bus manufacturers to better understand the range of small bus vehicles currently available and their relative technical characteristics.

- Vehicle test results were obtained from the Altoona Bus Testing Center in Altoona, Pennsylvania, to supplement the information obtained from the bus manufacturers and to provide a comparable basis for assessing the technical performance of these vehicles in a number of areas (e.g., fuel consumption and noise).

- The survey results helped identify a number of interesting applications of small buses. Case studies were then conducted by telephone or through on-site visits for a number of the most interesting sites. A special effort concentrated on locations that had not appeared in previous literature.

- In addition, a number of transit agencies provided data on the fuel and maintenance costs for their small buses.

The rest of this report will discuss the results of these efforts. Chapter 2 outlines the results from the two surveys of transit agencies. Chapter 3 presents the findings from several case studies. Chapter 4 discusses various aspects related to the technology. Chapter 5 synthesizes the experience, based on the research, whereas chapter 6 identifies a number of issues emerging from this experience. Finally, chapter 7 outlines the conclusions of the study.

CHAPTER TWO

USE OF SMALL BUSES (SURVEY RESULTS)

Surveys were sent to APTA and CUTA transit system members that had been identified as using small buses in services open to the general public. This survey is referred to as the "User" survey and is provided in Appendix A. Ninety-four agencies responded; a 45 percent response rate. They provided information on how they were using small buses and their experiences with them. These agencies operate more than 19,000 buses in a broad range of urban settings, from small towns to large cities, and in the wide range of climate conditions found in the United States and the lower Canadian provinces. Eighty-five percent of respondents were U.S. transit agencies, and 15 percent were Canadian. The transit agencies that provided information are listed in Appendix B. The results of this survey are discussed in the following sections. Appendix C contains information on the small bus fleets of the User survey respondents.

Additional information obtained from transit agencies with a lower wage rate for small bus operators is discussed in a later section. Finally, a brief survey was sent to APTA and CUTA system members identified as *not using* small buses in open services; that is, services other than ADA services or Specialized Transit Services in Canada, and the results from this survey are discussed in the last section of this chapter. This survey is identified as the "Non-Using" survey and is provided in Appendix A.

EXTENT OF USE

The transit agencies operating small buses represent a balance in terms of the type of areas they serve.

- Forty-five percent operate in predominantly urban areas,
- Twenty-four percent operate in predominantly suburban areas,
- Twenty-eight percent operate in small urban areas, and
- Three percent represented college or rural transit systems.

Those transit agencies that responded to the User survey ranged from large to small in terms of active fleet size. Table 1 illustrates the distribution of active fleet size of the User survey respondents.

TABLE 1
DISTRIBUTION OF "USER" SURVEY RESPONDENTS BY ACTIVE FLEET SIZE

Active Fleet Size	No.	Percent of Total
1–49	31	33
50–99	19	20
100–249	18	19
250–499	13	14
500+	13	14

Overall, small buses represented 18 percent of the total active fleet of the transit agencies that responded to the survey. However, the importance of small buses in an agency's fleet varies considerably with agency size, as illustrated in Table 2, which provides both the range and average by agency size (measured by the size of the active fleet). Small buses are much more intensely used by the smallest transit agencies (1–49 buses), ranging from three to 100 percent of the fleet, with an average of 64 percent, as compared to the 18 percent for the survey overall.

The small bus fleet as a percentage of the total active fleet, decreases as agency size increases: 32 percent for the 50–99 bus category, 22 percent for the 100–249 bus category, 19 percent for the 250–499 bus category, and 10 percent for the largest fleets. It should be noted that the weight for the second largest fleet category would be only 13 percent if one did not include the exceptional situation of the Suburban Mobility Authority for Regional Transportation (SMART), which operates a fleet that is 95 percent composed of small buses in suburban Detroit.

In terms of vehicles, the survey respondents reported operating 57 different types of small buses, ranging from

TABLE 2
SMALL BUSES AS A PERCENTAGE OF ACTIVE FLEET

	By Agency Active Fleet Size					For Entire Survey
	1–49	50–99	100–249	250–499	500+	
Range by Category: Small buses as % of active fleet	3–100%	8–94%	2–61%	1–95%	1–34%	1–100%
Average Weight by Category: Small buses as % of active fleet	64%	32%	22%	19%	10%	18%

van cut-a-ways to heavy-duty 30-ft buses. The small buses of the respondents are believed to be representative of the small buses in current use. Table 3 outlines the fleet distribution numbers according to the FTA service life categories, and Table 4 identifies the small bus models operated by the respondents according to the service life categories.

TABLE 3
NUMBER AND SERVICE LIFE OF SMALL BUS FLEETS USED BY SURVEY RESPONDENTS

Service Life	No.	Percent of Total
12-year	988	30
10-year	340	10
7-year	675	20
5-year	803	24
4-year	520	16
Totals	3,327	100

The size of the surveyed small bus fleets ranged from 1 to 433, and Table 5 presents the distribution of the small bus fleet size of the User survey respondents.

The survey requested information on the reasons why small buses were used, on how they were used, and on the experiences and overall satisfaction the transit agencies had with their small buses. These topics are discussed in the following sections.

REASONS FOR SMALL BUS PURCHASES

Table 6 outlines the survey responses concerning the reasons for small bus purchases. Seventy-four percent of the survey respondents cited each of the two following reasons as important: (1) matching capacity with demand, and (2) maneuverability on small streets. Although these two

TABLE 4
MANUFACTURER AND MODEL OF SURVEY SMALL BUS FLEETS BY SERVICE LIFE

Manufacturer and Model by Service Life				
4-Year	5-Year	7-Year	10-Year	12-Year
Champion Crusader	Champion Sentry	Advanced Vehicle Systems AVS-22	Blue Bird CSTS	Champion Contender
Champion Challenger	Diamond TC 2700	Chance Coach RT-52	Blue Bird QBRE	ElDorado–National E-Z Rider
Champion Commander	ElDorado–National Aerotech 200	Champion CTS	Blue Bird MB IV	Flxible Metro 30
Coach & Equipment Phoenix	ElDorado–National Aerotech 220	Champion Centurion	Champion Contender	Gillig Phantom 30
Diamond VIP 2500	ElDorado–National Aerotech 240	ElDorado–National Escort	Champion So Lo	Orion Bus Industries Orion I
Goshen Coach GCII	ElDorado–National AeroLite	ElDorado–National MST	ElDorado–National Transmark RE	Orion Bus Industries Orion V
Goshen Coach Pacer	Goshen Coach GC II 30'	ElDorado–National ELF		Orion Bus Industries Orion II
Girardin MBC	Goshen Coach Sentry	Gillig Spirit		New Flyer Industries D30LF
Metrotrans Classic		Thomas Built Bus 3000		New Flyer Industries C30LF
Supreme BSGP		Thomas Built Bus Vista Cruise		Nova Bus RTS 30'
Supreme Startran		World Trans 3000		
Supreme Metrotrans		World Trans AT Mid Bus 28		
Turtle Top CP30				
World Trans Diplomat				
World Trans Royale 1600				
VANS				
Chrysler Minivan				
Dodge Caravan				
Dodge Maxivan				
Dodge RAM Van				
Dodge Van Conversion				
Ford Van				

TABLE 5
DISTRIBUTION OF SURVEY SMALL BUS FLEETS BY SIZE

Small Bus Fleet Size	No.	Percent
1–9	23	24
10–24	35	37
25–49	17	18
50–99	14	15
100+	5	5

reasons were cited most frequently, matching capacity with demand was ranked highest with 50 percent of respondents giving it a first or second place ranking; maneuverability on small streets was ranked second, with 39 percent. As Table 6 shows, other hypothesized reasons were considerably less important. Respondents also reported a number of "other" responses that included a weight limitation on a bridge, mandated service, and more efficient means of providing service.

The ability to match capacity with demand and maneuverability on narrow streets were therefore the most important attributes of small buses in the eyes of transit managers. On the other hand, the availability of special funding, such as Congestion Mitigation and Air Quality (CMAQ), played a minor role in the decision to purchase small buses.

HOW SMALL BUSES ARE USED

Ninety-three transit agencies provided information on how they used their small buses. The dominant use for these transit agencies was scheduled fixed-route service. This finding is consistent with the most important reason, that is, matching capacity with demand, cited previously for implementing small bus service. Table 7 includes the responses to the survey question on the types of services in which small buses were used. Data are provided for all respondents and are also broken down by agency size.

The survey identified several alternative nontraditional uses of small buses including downtown circulator, neighborhood circulator/community bus, route deviation, flexible feeder services, and demand responsive zone service. The distribution among four of these alternatives was remarkably balanced, with between 26 and 29 percent reporting the use of small buses in these types of applications. Flexible feeder service was slightly lower, with only 12 percent reporting this type of application. However, an unclear definition of this service may have caused this response.

Service applications reported under the "Other" category included

- Park & ride shuttle,
- Commuter rail feeder shuttle,
- Airport shuttle,
- Nature center shuttle, and
- Senior volunteer driver program.

An interesting observation occurs when comparing the uses made of small buses among the different size transit

TABLE 6
REASONS FOR PURCHASING SMALL BUSES

Survey Reason Choices	1st or 2nd Ranking (%)	No. of Times Cited (%)
Complaints from community/residents (with respect to noise, vibration, etc.)	17	38
Funding allowing experimentation (e.g., CMAC, etc.)	2	18
Lower capital costs	10	48
Lower operating/maintenance costs	11	41
Maneuverability on small streets	39	74
Marketing image	17	57
Matching capacity to demand	50	74
Other	6	8

TABLE 7
TYPES OF SERVICES USING SMALL BUSES

Types of Open Services	Responses by Size of Active Fleet			
	1–99 (50 agencies) (%)	100–249 (18 agencies) (%)	250 + (25 agencies) (%)	All (93 agencies) (%)
Scheduled fixed route	78	72	85	80
Neighborhood circulator/community bus	16	44	42	29
Demand responsive zone service	28	39	15	27
Downtown circulator	18	39	31	26
Route deviation	26	22	27	26
Flexible feeder services	10	17	12	12
Other	20	22	12	18

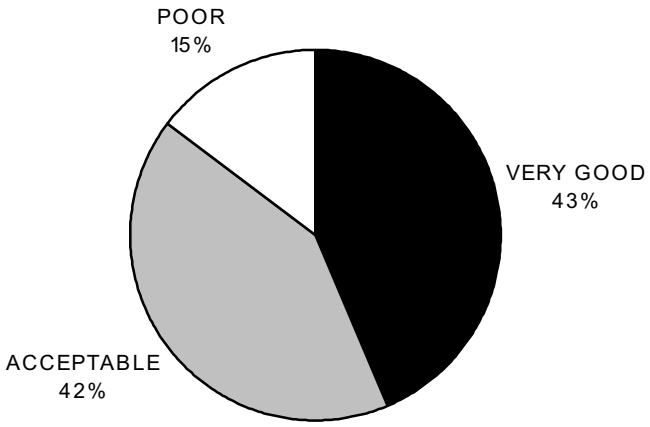

FIGURE 1 Distribution of overall experience with use of small buses.

agencies. Medium-size transit agencies (100–249 buses) report the highest use of small buses in four of five of the "nontraditional" application categories (i.e., community bus, downtown circulator, demand responsive zone service, and flexible feeder). The only exception is for route deviation service. In addition, the percentage of agencies in this size category that use small buses for nontraditional applications is sometimes significantly higher than the overall average. For example, 44 percent of medium-size transit agencies use small buses for community bus service versus only 29 percent for all respondents. With respect to demand responsive service open to the public, it is 39 percent for medium-size agencies versus 27 percent overall. It would appear that medium-size transit agencies are somewhat more likely to implement non-traditional applications using small buses, particularly, for the implementation of demand responsive or flexible feeder services.

OVERALL SATISFACTION

In response to the survey question, "Has your overall experience with the use of small buses been Very Good, Acceptable, or Poor?," most transit agencies reported either Very Good or Acceptable experiences. Figure 1 shows the distribution of experiences of 89 transit agencies.

Because 85 percent of the responses were either Very Good or Acceptable, it appears that the operational experience with small buses has been good. This overall high level of positive experience comes as a surprise, because in discussions with transit agencies, complaints about small buses were frequent.

A further examination of the survey data reveals an interesting difference between transit agencies that are predominantly small bus fleets and those that are predominantly large bus fleets. There were 23 survey respondents with active fleets having 90 percent or more large buses, and there were 12 survey respondents with active fleets that were 90 percent or more small buses. The difference in overall experience of these two groups is revealing and is shown in Figure 2.

Essentially, these findings show that transit managers that operate small bus fleets are quite content with the vehicles they operate, whereas those operating essentially large bus fleets are far less satisfied with the smaller buses.

The overall operating experiences with small buses were also analyzed by size of transit agency to determine if there was any difference in their perceived experience. The survey responses were analyzed by size of active fleets, and the results are provided in Table 8.

The size of a transit agency did not seem to be a determining factor in whether or not their experience with small buses was good or poor. As the data show in Table 8, no pattern of significant difference was found in the overall operating experiences by size of the transit agency. A higher percentage of the medium-size transit agencies did report greater dissatisfaction with small buses than the other two groups. This more frequent Poor experience seems more a function of the small buses that were used than the size of the active fleet.

Is there a bias against small buses in transit agencies with predominantly large buses in their fleets, or do they unintentionally have a higher standard for vehicle performance based on their experience with large buses? The following section offers further insight on the reported issues and concerns about the use of small buses.

ISSUES RAISED

As discussed in the previous section, most transit agencies were satisfied with their overall experience with small

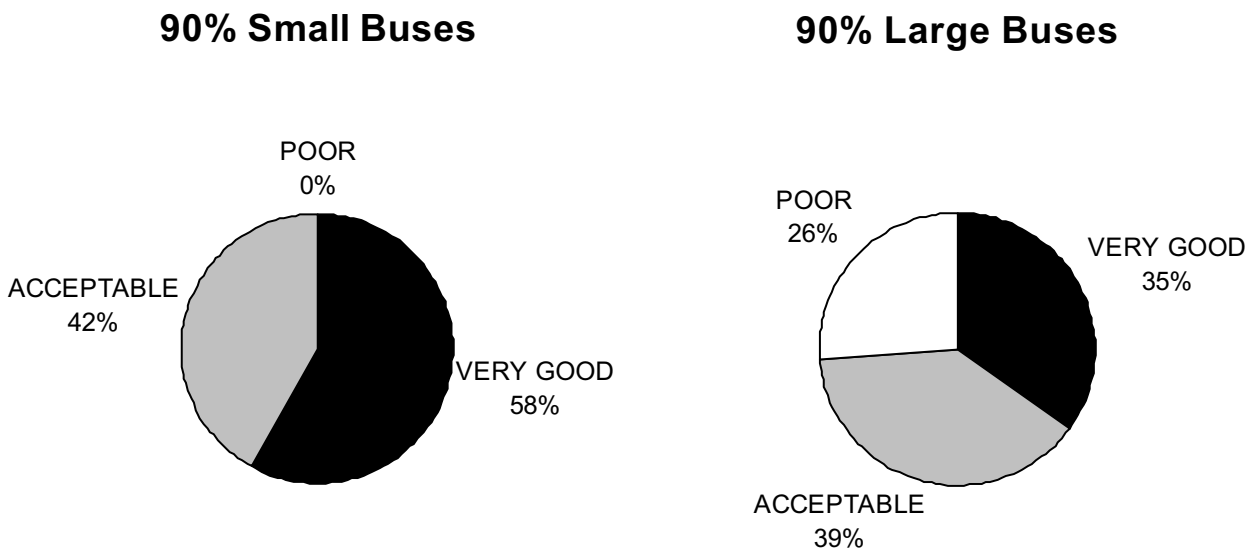

FIGURE 2 Difference in reported experience with the uses of small buses.

TABLE 8
REPORTED EXPERIENCE WITH SMALL BUSES BY SIZE OF ACTIVE FLEETS

Operating Experience	Transit Agencies by Active Fleet Size		
	1–99 (%)	100–249 (%)	250 + (%)
Very good	50	42	33
Acceptable	40	29	54
Poor	10	29	13

buses. Survey respondents were asked: Have there been any major issues or concerns raised by your use of small buses? They were then asked to rank by importance the following issues:

- Capital cost of vehicle,
- Customer acceptance,
- Maintenance costs,
- Operator acceptance,
- Safety,
- Vehicle reliability, and
- Other.

Sixty-three transit agencies provided information on their issues and concerns. Because many of the transit agencies had more than one type of small bus in their fleet, some of the issues and concerns were for specific vehicle types. Table 9 provides information on the percentage of total responses that cited an issue/concern as important, and the percentage of responses that cited an issue/concern as either first or second in importance.

As seen in Table 9, concerns about vehicle reliability and high maintenance costs were both the most frequently cited and highest ranked concerns, with customer acceptance a close third. The customer issues were poor ride, noise, fumes, single door, and crowding. Just over one-half of the survey respondents operating small buses, particularly with respect to the 4- and 5-year service-life vehicles, reported that vehicle reliability was an issue, and 42 percent believed that they had higher maintenance costs than anticipated.

A few of the transit agencies cited as an issue the relatively high cost of a small bus and its limited use when compared with a standard large bus. Safety was cited only once as being the most important concern with the use of small buses, without specific explanation. The most frequently cited safety concern was for standees.

The Other concerns included the following:

- Lack of seats,
- Inflexibility in assigning to routes,
- Lack of capacity at peak hours,
- Operator work station ergonomics, and
- Life of small buses.

As discussed in the previous section, transit agencies provided information on their "overall experience" using small buses, and this response was compared to the responses

TABLE 9
SURVEY RESPONSES ON CONCERNS RAISED WITH THE USE OF SMALL BUSES

Issue/Concern	Percent of Responses	
	Cited as Issue/Concern (%)	Cited as Most Important (%)
Capital cost of vehicle	17	3
Customer acceptance	39	14
Maintenance costs	42	13
Operator acceptance	33	6
Safety	12	2
Vehicle reliability	53	25
Other	33	16

TABLE 10
ISSUES/CONCERNS WITH USE OF SMALL BUSES FOR THREE SUBGROUPS

Issue/Concern	Percent of Times Cited by Subgroup (based on reported experiences)		
	Very Good Subgroup (%)	Acceptable Subgroup (%)	Poor Subgroup (%)
Capital cost of vehicle	8	11	23
Customer acceptance	22	27	54
Maintenance costs	11	35	77
Operator acceptance	11	22	62
Safety	3	16	0
Vehicle reliability	22	38	85
Other	19	30	23

with respect to "issues of concern." The responses to the question on specific issues/concerns were then divided into three subgroups: those reporting very good experience, acceptable experience, and poor experience. An analysis of the number of times cited for each issue/concern for each of these subgroups was made to see whether or not there were any differences between these groups, and the results of this analysis are shown in Table 10.

Table 10 shows that the concerns of vehicle reliability and high maintenance costs were frequently cited by transit agencies that had Poor overall experiences using small buses. In other words, the issues of vehicle reliability and maintenance costs were sufficiently important to affect negatively the overall experience with the use of these buses. It is also interesting to note that agencies with Poor experiences seemed to be more critical on all issues (with the exception of safety).

LOWER WAGE RATES FOR OPERATING SMALL BUSES

Twenty-three of the User survey respondents (24 percent) reported that they had a different wage rate for drivers operating small buses. As previously mentioned, a follow-up survey was then sent to these agencies to obtain additional information about this small bus wage rate.

Fourteen agencies (61 percent) provided additional information concerning the following three questions:

- What was the small bus wage rate and how did it compare to the large bus wage rate?
- What constraints were there, if any, on the number of operators that could be employed at the lower wage rate?
- What was the relationship between the different categories of small bus and large bus operators in terms of seniority and progression?

A variety of definitions for small bus operators were used including

- By length of vehicle—Typically, this approach used "less than 30 ft in vehicle length," although at least one agency also used a definition of 24 ft. One agency reported that this definition created a conflict with the union with respect to the inclusion of the bumper in defining length, because a nominal 30-ft bus may exceed 30 ft if the bumper is included.
- By number of seats—In one agency, the small bus wage rate applied to buses with 25 or fewer seats; an even lower rate was used if the vehicles had 12 or fewer seats.
- By type of service for the route/run—In this case, the lower wage rate would apply to specifically designated routes/runs, under many different names (e.g., community shuttle, minibus routes, small transit vehicle runs, low productivity routes, dial-a-ride, paratransit, etc.). The identification of these routes/runs was determined under sometimes complex procedures negotiated in the labor contract. In at least one case,

the procedure identified the number of operators who would be paid the lower wage rate starting from the bottom of the seniority list, irrespective of what run or vehicle was actually operated.

An additional point to note is that the definition of these routes/runs did not always correspond to a special category as seen by customers.

In terms of actual wage rates, for those agencies that provided detailed wage rates, the top small bus wage rate, expressed as a percentage of the top large bus wage rate, ranged from 55 to 80 percent. The average reported top small bus wage rate was 69 percent of the top large bus rate for those who provided this information.

In terms of benefits, most agencies provide small bus operators similar guarantees and benefits as those provided to large bus operators. However, in at least two systems, small bus operators were considered as permanent part-time workers and were only paid for the hours they actually worked, with no shift premiums or guarantees.

It should be noted that three agencies reported operating small bus services under contract with private companies, based on an all-inclusive per hour fee. In these cases, the agencies did not know the wage rate being paid, and it was not comparable in any case to the rate paid to the public agency operators.

Finally, one agency, the York County Transportation Authority (York, Pennsylvania) reported that they had negotiated a "low productivity wage rate" as opposed to a "small bus wage rate," because they have three routes with very low overall productivity levels, but have extremely high "tripper" loads at certain times of the day, which requires a large bus. The lower wage rate can apply if a route consistently achieves productivity of nine passengers per hour or less, provided a guaranteed minimum number of higher paid runs are maintained.

Sixty-six percent of the agencies reported that they had no constraints on the use of the lower wage rate. The constraints reported by the other agencies took a variety of forms, including a negotiated, specific number of operators at the lower rate; a guaranteed number of runs at the full wage rate; or as a percentage of the large bus fleet at the peak. Two agencies also mentioned a dual approach that had been negotiated in the contract: on the one hand, a cap was placed on the number of routes or buses previously operated at the full wage rate that could be converted to the lower wage rate, and on the other hand, no limits existed on the number of totally "new" routes that might be created and operated at the lower wage rate.

Finally, in terms of the third question, in most cases the two pools of operators were generally reported to be *formally* separate. There was a distinct hiring process for each of the two pools, and each group had its own training period, progression, and seniority list. For example, in one case, small bus operators received 3 weeks training, whereas large bus operators had 5 weeks training.

In some cases, openings were posted separately by category, but special consideration was generally given to large bus operator candidates who were already small bus operators in the same agency. To the extent that large bus operators are only selected in this manner, it equates to creating an extended progression process.

At least two agencies have fully integrated the two groups of operators with a single bidding list by seniority. Another agency maintains two separate lists, but only fills openings for large bus operators from among existing small bus operators. In this agency, because it typically takes a small bus operator 3 to 4 years to be promoted to the large bus category, the progression as a large bus operator has been reduced to 60 days.

Respondents identified one significant issue with respect to senior operators. Operating a small bus is often viewed by operators as a more desirable job than operating large buses: The passenger loads and scheduling are lighter, the runs are typically straight runs, and the neighborhoods are often more pleasant. Therefore, a small bus wage rate that is lower than that for operating the more onerous large buses is consistent. However, this may also create conflict with respect to senior operators who would like to choose these runs. Several agencies reported that senior operators prefer to choose these runs, even at a lower rate of pay. This may become a more serious issue if the formal or informal seniority and hiring policies only allow recently hired operators to select these runs. One agency reported that this is a potential strike issue in the next round of negotiations.

SURVEY OF TRANSIT SYSTEMS THAT DO NOT USE SMALL BUSES

As previously mentioned, a second survey was mailed to those transit agencies that did *not* operate small buses. Fifty-four responses were received. It was believed that this survey might shed some additional insight as to the major perceived reasons and obstacles that have limited the implementation of small buses. This survey is referred to as the "Non-User" survey and can be found in Appendix A. Although a number of the respondents of the Non-User survey reported using small buses, there was not adequate time to send a follow-up survey to the agencies.

These agencies were asked to rank what was the most important reason why they had chosen not to purchase and operate small buses. They received the same list of potential issues or concerns provided in the User survey.

- Capital cost of vehicle,
- Customer acceptance,
- Maintenance costs,
- Operator acceptance,
- Safety,
- Vehicle reliability, and
- Other.

Nineteen systems not using small buses provided information on why they decided not to use small buses. A breakdown of their responses appears here and provides additional insight about small bus issues.

- Forty-seven percent of the Non-User respondents ranked Maintenance Costs as either the number 1 or 2 reason that they chose not to implement small buses.
- Thirty-two percent of the Non-User respondents ranked Capital Costs as the number 1 or 2 reason that they chose not to implement small buses.
- Vehicle Reliability was also reported by 32 percent of the respondents as the number 1 or 2 reason, although fewer cited it as the most important reason, compared to Capital Costs.
- Safety of small buses did not appear to be a concern for those agencies that had not implemented small buses. It was the least cited reason (26 percent of the respondents), and its highest ranking was only fourth place.
- In addition, the issue of insufficient capacity provided small buses dominated the Other issue category (two-thirds of Other responses). Respondents believed that the smaller passenger capacity of these vehicles prevented them from being interchangeable with standard buses at peak times, which constrained their use. Some respondents felt that they could not afford to have a mixed fleet with buses not used during peak hours.

COMMON CONCERNS FROM BOTH USERS AND NON-USERS OF SMALL BUSES

Table 11 compares the ranking of reasons given by non-users for not using small buses, with concerns/issues by users who have implemented small buses.

The higher percentages for the Non-Users stem from the different role this question served in the survey where it was the essential question being asked, although it was only filled in by Users if they had a concern they wished to report. Nonetheless, there are some interesting results that emerge from this side-by-side analysis.

- For both Users and Non-Users Vehicle Reliability was cited most frequently as a concern.
- Maintenance Costs was the second most frequently cited by both groups.
- The two groups differed very significantly, however, with respect to the capital cost of the vehicle. Non-Users ranked this issue as the second most important reason given for not implementing small buses, while Users ranked it next to last. This may be partly explained because before the acquisition decision this issue may loom large as a concern, but it is much less significant once the vehicles have been purchased and put into service. Nonetheless, it would appear that Users have far less concern about the relative cost of small buses even though with its lower average shorter lifetime, they do need to be replaced more frequently. This was corroborated by the fact that there were only two of the user agencies that had used small buses that were abandoning or signifiantly reducing their use.
- The rankings for Customer Acceptance, Operator Acceptance, and Other Concerns were comparable between both Users and Non-Users.
- Among the Other issues cited, Insufficient Capacity dominates for both groups.
- There is agreement between Users and Non-Users that Safety is not really a concern, and it is cited the least frequently.

This comparison indicates that there are three areas of common concern for both users and non-users of small buses. These are, by order of importance

- The reliability of the vehicles;
- The maintenance costs of small buses, which is related to the previous issue; and
- The capacity of the vehicle, and the perceived constraints that this may impose on its deployment.

TABLE 11
CONCERNS OF USERS AS COMPARED TO REASONS CITED BY NON-USERS

Concern/Reason	Percent of Responses	
	Cited as Reason for Not Implementing Small Buses by "Non-Users" (%)	Cited as Concern By "Users" (%)
Vehicle reliability	79	53
Maintenance costs	68	42
Capital cost of vehicle	68	17
Customer acceptance	42	39
Operator acceptance	42	33
Safety	26	12
Other	32	33

CHAPTER THREE

SMALL BUSES AS A COMPONENT OF FAMILY OF SERVICES

KANSAS CITY AREA TRANSPORTATION AUTHORITY

The Kansas City Area Transportation Authority (KCATA) has pursued one of the most comprehensive strategies for implementing small buses among North American transit systems. KCATA is a strong advocate of small buses. The Authority believes that the use of small buses, combined with a lower wage rate that is commensurate with the less onerous task of operating small buses, can provide transit agencies with a cost-effective tool for providing service in otherwise lean economic areas or times of lower demand. The higher levels of service provided benefit the community.

Background

In the 1970s, a controversy arose in Kansas City concerning use of small buses. The community had expressed a strong desire to see small buses implemented, but the management at the time resisted because the cost savings would be nominal for lack of a differential wage rate. With the arrival of a new general manager, management began negotiating with the union to seek a different wage rate for small buses. Initially, in the mid-1980s, the union allowed KCATA to provide such service on two *new* routes. The union was thus protecting itself from the conversion of large to small buses and lower wage rates on all existing service. Small buses were defined as vehicles with 25 or fewer seats. This limited implementation illustrated the benefits to be derived from the use of small buses, and over the next 10 years, there was an ongoing debate with the union concerning the implementation of additional small buses. However, concurrently, KCATA was in the process of downsizing its operations because of reduced operating assistance. As a result, ridership was decreasing, and thus on many routes where buses were operating at less than capacity, a small bus could easily meet the remaining demand.

Management was able to negotiate the conversion of some routes to small buses at the lower wage rates. All of the routes were relatively small. By 1995, the Authority's small bus fleet reached approximately 20 vehicles. KCATA was still operating 220 large buses at the time, and approximately 25 percent of the routes operating with large buses were candidates for conversion because of low ridership, but were constrained by the union agreement.

In addition, KCATA was receiving a growing number of requests for service in limited markets, primarily in the more distant suburbs, where an even smaller capacity vehicle could provide the service. Management subsequently negotiated the right for two new routes that used 12-passenger vehicles, with an even lower percent wage rate for the drivers.

In 1996, the expired labor contract was submitted to binding interest arbitration, with management seeking unconstrained conversion to smaller buses when desirable. The arbitration granted management the right to conversion as they saw fit, provided that no existing bus operator would be forced to take a pay cut. This has been accomplished by matching the rate of conversions to just below that of driver turnover, which have been approximately five driver positions per quarter. When a candidate route for conversion requires more than five drivers, conversion would be delayed one quarter until sufficient driver attrition had occurred. Since 1996, approximately 40 large bus routes have been converted.

In addition, the 1996 arbitration also allowed KCATA management to convert 25-passenger buses (operated with a wage rate of 75 percent of the large bus wage rate) to smaller 12-passenger van cut-a-ways, called MetroFlex service. This service would be operated using a special MetroFlex wage rate set at 55 percent of the large bus wage rate. The arbitrator, however, set a condition that the MetroFlex wage rate could only be applied if the service involved "meaningful flexibility"; although a specific definition was not provided. For example, drivers operating 12-passenger van cut-a-ways, but on routes that did not involve a "meaningful" degree of flexibility, are paid the normal small bus wage rate of 75 percent. The concept of "meaningful flexibility" has been gradually clarified over time through successive grievance challenges and arbitrations. In 2000, as a result of these changes, KCATA was operating a fleet of 206 large buses, 85 small buses, and 35 van cut-a-ways.

These arrangements have given KCATA the unique opportunity to "right-size" any service in the area. It has justified the smaller buses not only in terms of their greater flexibility, but also in terms of significant cost savings, and these savings have been reinvested in additional service.

Use of Small Buses

KCATA operates small buses in a variety of services, which are discussed in the following sections.

Small Bus Routes

KCATA operates 40 routes with small buses on secondary streets in the urban core or on suburban routes. As discussed previously, the implementation of small buses at KCATA has occurred over the last 15 years, under three distinct sets of circumstances.

- The original small bus routes that had been negotiated with the union, route by route, before the 1996 arbitration;
- New services created since 1996 that did not duplicate existing services and were implemented primarily in the suburbs; and
- Conversions since 1996 of former large bus linehaul routes that have been roughly implemented at the rate of driver turnover.

Most of the small bus routes are designated with the nomenclature of three-digit 100 or 200 series routes, to distinguish them from the two-digit routes operating with large buses. However, this is changing as conversions continue, and KCATA is now moving into partial conversions, by time of day (off-peak), when small buses replace large buses.

The vast majority of the small bus routes are operated with 25-passenger, 30-ft buses. Although more than 25 seats could be accommodated in the 30-ft buses, that is the limit established through negotiations with the union for the small bus wage rate. In some cases, smaller 12-passenger van cut-a-ways are used on new suburban small bus routes, because they more closely match demand and reduce fuel and maintenance costs. They are, however, operated with the small bus, rather than the MetroFlex, wage rate.

KCATA also runs a North/South Downtowner loop catering primarily to downtown office workers and shoppers during weekdays. This service was one of the new services established and is operated with a small bus in a unique full bus paint scheme, at approximately 400 trips per day. A second East/West Downtowner is operated under contract, using a rubber-tired trolley coach on an East/West loop. Both Downtowner services are operated on a 10-min headway, with a flat fare of 25 cents, and allow transfers to the other Downtowner loop.

MetroFlex Routes

These six routes involve the use of the smaller 12-passenger van cut-a-ways (see Figures 3 and 4) in areas of low demand, primarily in the suburbs. In most cases, the routes combine a fixed-route service during the morning and afternoon peaks, and an on-request service within a specified zone during the off-peak (midday, evenings, and weekends if service is provided). Customers call a common telephone number for all MetroFlex services and can request a pick-up 24 hours in advance. In addition, all MetroFlex services offer the option of establishing a "standing order" if customers are making trips to the same location at the same time on a daily, weekly, or monthly basis.

In addition to the off-peak on request service, most of the MetroFlex routes offer flexibility at peak times as well, although this takes different forms for different routes. In some cases, the service is offered as a route deviation, where customers can either board or be dropped off at specified times, or request to be picked up or dropped off within some specified distance from the route (one or two blocks off route or within the rush-hour pick-up area specified on the

FIGURE 3 KCATA MetroFlex 12-passenger bus (exterior).

FIGURE 4 KCATA MetroFlex 12-passenger bus (interior).

schedule). In another case, the fixed route is extended to a specific employment center upon request. In still another instance, a minimal set of fixed timepoints are specified, and customers can be picked up or dropped off anywhere along the route, provided it is arranged in advance.

Four of the MetroFlex routes are operated using drivers paid at the MetroFlex wage rate, which is 55 percent of the large bus wage rate. As determined by the 1996 arbitration, a route can qualify for the lower MetroFlex rate if it involves a significant level of flexibility. In practice, this level means that the route must have flexible service characteristics at all times (e.g., zone-based requests during off-peak and route deviations during peak service).

Development of New Service Design Concepts

With the growing suburbanization of the area, KCATA has started exploring and introducing some new service concepts, including

- Transit Centers that have been created in three suburban locations and provide a convenient transfer point for different types of routes.
- Circulator Routes using 12-passenger van cut-a-ways to provide a feeder-type service into Transit Centers.
- Connector Routes providing connector service between Transit Centers, with either large or small buses, as demand justifies.
- Reverse Commuter Service, such as the MetroFlex Job Link Flex, providing a direct connection from downtown to suburban employment areas.

In addition, KCATA uses the flexibility offered by the range of service types it can provide to explore different options for service in the more self-contained suburbs located farther away. For example, small buses were used as the basis for rebuilding transit service in the city of Independence, Missouri, located 12 miles from downtown Kansas City, on the fringe of the service area. The city of Independence had capped local funding in the early 1990s resulting in its existing seven routes being paired back to two. In 1997, a new self-contained service plan was implemented in the city. It involved six routes feeding into a Transit Center, connected to downtown Kansas City by means of a heavily used large bus trunk route. Starting with modest expectations, 12-passenger van cut-a-ways were deployed on five of the routes, with the sixth route operating a 25-passenger bus. This spurred growth in ridership and, in 1999, four of the routes were operating the 25-passenger small buses. Demand remains low on the two other routes, and MetroFlex options are being considered. These routes illustrate the experimentation that is now feasible with the planning options available to KCATA.

Comparison of Services

Table 12 provides a comparison of the three different types of services offered by KCATA and illustrates the significance

TABLE 12
RELATIVE IMPORTANCE OF EACH TYPE OF SERVICE WITHIN KCATA FLEET

Routes	Percentage of Total Routes	Percentage of Daily Vehicle Mileage (average weekday)	Percentage of Daily Direct Operating Cost (based on weekday allocation)
Large bus	26	58	65
Small bus*	68	40	34
MetroFlex routes (with MetroFlex wage rate)	6	2	1

Source: KCATA (*3*).
*Includes two MetroFlex routes operated with small bus wage rate.

TABLE 13
COMPARISON OF PASSENGERS PER HOUR BY TYPE OF ROUTE

Type of Route	No. of Routes	Passengers per Hour (range)	Passengers per Hour (average by category)
Large bus routes (unchanged)	16	7.3–32.9	21
Converted routes since 1996 (large bus to small bus)	12	6.8–19.8	13
Original small bus routes (negotiated prior to 1996)	8	6.6–13.8	10
New small bus routes (created since 1996)	22*	1.4–12.5	6
MetroFlex routes with MetroFlex wage rate	4	3.1– 5.9	4
KCATA—all routes	62	1.4–32.9	19

Source: KCATA (*3*).
*Includes two MetroFlex routes operated with small bus wage rate.

of small buses in the KCATA system. Small bus and MetroFlex services represent 74 percent of the designated routes, 42 percent of weekday vehicle mileage, and 35 percent of weekday daily operating costs, based on KCATA's cost allocation model.

Table 13 presents a more detailed comparison of passengers per hour by type of route, based on the circumstances under which the routes were created. Large buses, not surprisingly, are used on the heavier than average demand routes. The original small bus routes are in the middle range since they represent the first new routes implemented in the late 1980s and early 1990s. Since 1996, the agency has used small buses in three distinct areas (numbers in parentheses are passengers per hour).

- Conversions of poor performing large bus routes, with average passenger loads higher than the original small bus routes (10/h), but lower than the remaining large bus routes (21/h);
- New routes, primarily in the suburbs, using both 25- and 12-passenger vehicles, where demand is on average 43 percent lower than the original small bus routes (6/h); and
- MetroFlex routes that with the MetroFlex wage rate, present a cost-effective means for providing service in distant suburbs where demand is even lower (4/h).

KCATA has developed a sophisticated system monitoring process that provides information on a route-by-route and monthly basis. It involves a cost allocation model based on the experience to date with all of the different categories of services. The cost allocation model uses factors that have both vehicle miles and hours as input. Table 14 illustrates the factors used for allocating costs among the three types of services. These cost factors are based on KCATA's experience with these various services and reflect both the lower wage rates (primarily in the hourly cost factor) and the lower fuel and maintenance costs (primarily in the mileage-based cost factor) for the small bus and the MetroFlex services, as compared with the cost of operating large buses.

KCATA's operational funding approximately brakes down as follows: Farebox (20 percent), local sources (60 percent), and state and federal (20 percent). The bulk of the local funding is based on service contracts with the seven largest municipalities in the seven-county region. The service contracts are renegotiated every year. A formula has now been established for the implementation of new services using small buses. The municipality funds 60 percent of the cost of the service (equivalent to the average contribution from local sources), plus the difference between the actual recovery ratio and the average 20 percent recovery ratio for the agency. The much lower operating costs for small bus services, as seen in Table 14, have

TABLE 14
COMPARISON OF COST ALLOCATION FACTORS BY TYPE OF SERVICE

Routes	Hourly Based Cost Allocation Factor* (as percentage of large bus cost factor)	Mileage-Based Cost Allocation Factor* (as percentage of large bus cost factor)
Large bus	$26.13	$0.3933
Small bus	$19.00 (73%)	$0.2979 (76%)
MetroFlex	$14.19 (54%)	$0.1730 (44%)

Source: KCATA (*3*).
*The cost allocation factors are derived from KCATA's cost allocation model and represent the relative contributions of each mode, by hour and mileage, to the system's overhead.

TABLE 15
KCATA BUS FLEETS

Manufacturer Model	Service Life Category	Length (feet)	No. of Seats	No. of Vehicles	Year(s) Purchased	Ave. Age of Fleets
			Large Bus Fleet			
Gillig Phantom 40	12	40	43	39	1996	4
Nova Bus RTS T80 206	12	40	43	165	1987, 1989, 1993, & 1994	10.4
Gillig LF 40	12	40	43	2	1999	1
Totals Large Bus Fleet				*206*		*8.3*
			Small Bus Fleet			
Gillig Phantom 30	12	30	25	53	1995, 1998, 1999, & 2000	1.2
ElDorado–National Transmark RE29	10	30	25	32	1997	3
Totals Small Bus Fleet				*85*		*1.9*
			MetroFlex Fleet			
ElDorado–National Aerotech	5	22	12	23	1998, 1999, & 2000	1.0
Goshen Coach GCC II 801	4	20	12	12	1996 & 1997	3.33
Totals MetroFlex Fleet				*35*		*1.8*
Total Small Buses I (30 ft or less)				*120*		

Sources: APTA (*2*) and KCATA (*4*).

enabled municipalities to consider implementing new services even in areas of very low demand.

Vehicle Considerations

The KCATA bus fleets are composed of 206 buses in the large bus fleet (40 ft), 85 buses in the small bus fleet (30 ft), and 35 buses in the MetroFlex fleet (20 and 22 ft). (It should be noted that MetroFlex Fleet in Table 15 is the designation used by the maintenance department, although these vehicles are actually used in both MetroFlex and other small bus services, as discussed previously.) Table 15 offers additional information on these fleets.

During the site visit, a KCATA fleet maintenance *Status Report* (*4*) was provided that contained information on fleet fuel consumption and mechanical road-call experiences. The report provided information for a 19-month period. Table 16 provides a summary of the information contained in the report.

The fuel economy of the small bus fleet is approximately 39 percent higher than that of the large bus fleet, and the MetroFlex fleet fuel economy is approximately 164 percent higher than that of the large bus fleet. The mechanical road-call experience with the MetroFlex fleet is very good, and the small bus fleet experience is mixed.

The first generation of small buses acquired was of the body-on-chassis type. The ride quality was hard and customers preferred the larger buses. Since then, a new generation of a 30-ft version of a large bus has been acquired. The quality of the ride has improved, and customer complaints have decreased. With only 25 seats, these buses are also more capable of accommodating standee loads when these occasionally occur. Another somewhat smaller vehicle was also considered as a replacement for the first

TABLE 16
KCATA VEHICLE OPERATING EXPERIENCE

Bus Subfleets	Avg. Age (years)	Fuel Economy (mpg)	Avg. Miles Between Mechanical Roadcall
Large bus fleet	8.3	3.33	8,225
Small bus fleet			
10-year service-life bus	3	4.69	3,661
12-year service-life bus	1.2	4.5	9,520
MetroFlex fleet			
5-year service-life bus	1	8.7	16,054
4-year service-life bus	3.3	8.74	12,908

Source: KCATA (*4*).

generation vehicles. However, mechanics found it more difficult to maintain. In terms of the smaller 12-passenger van cut-a-ways, acceptance has been satisfactory, but trip duration tends to be shorter.

Other Issues

Three other issues are worth noting. The first concerns *customer recognition and branding*. KCATA has made an interesting effort to distinguish the different types of service in its schedules by illustrating on the schedule cover a pictograph representing the type of bus used for that service (see Figures 5–8). There had also been in the past some correspondence between the bus route nomenclature and the type of service, as previously mentioned. However, this correspondence is not carried into the system map through a special use of color-coding for different types of services or explanations about the services.

In addition, the MetroFlex service receives an additional branding in terms of a consistent logo on the schedules, the use of color for Flex on some of the schedules, a common telephone number, and the inclusion of MetroFlex in the route name (e.g., "Route 234–Tiffany Springs MetroFlex"). However, the actual concept of MetroFlex service design varies for all six routes, and one needs to consult the specific route schedule to obtain a specific understanding of the service provided on any one of these routes. This enables the agency to tailor the design to the specific circumstances of an area, but may make it more difficult to foster customer recognition and understanding.

In general, this procedure raises the issue of trade-offs between increased branding and structuring of service concepts to facilitate customer ease of use and flexibility of design and implementation, which is required because small buses are often used for experimental services that may or may not survive. Another example, occurring at KCATA, concerns the bus pictograms on the schedules. The agency is now moving into conversions of large bus routes by time of day, implementing small buses during midday. How should this mixed service be portrayed on the schedules and is there any risk of confusion for customers?

A second issue concerns *the flexibility offered by the array of service concepts to design future comprehensive approaches to transit planning.* As discussed, KCATA has experimented with various new service design concepts, but implemented them on an individual and small-scale basis over the last few years. However, there has also been a comprehensive transit planning effort for the entire region that has been undertaken in parallel over the last 4 years. In 1996, a Public Transit Planning Study was issued by the Mid-America Regional Council, which assessed changing demographic and economic trends and identified the growing need for transit services to, between, and within suburban communities. It framed the future of transit in the region around a collection of community-based transit centers or service areas. This study was followed in 1998 by a Metropolitan Transit Initiative Demand Assessment, and in 2000 by a Comprehensive Metropolitan Transit Initiative Plan (*5*). These studies identify three fundamental types of service that would serve the transit centers/service areas.

- Commuter Express—providing unidirectional peak, commuter-oriented express service to downtown Kansas City or other major employment centers.
- Connector Service—providing bi-directional peak and nonpeak service to connect the transit centers/service areas.
- Community-Based Service—provided within each Transit Service area, typically feeding into the transit centers.

Choice of vehicles and route structure for community-based services would vary depending on population density and market characteristics. KCATA could provide fixed-route transit service on a grid pattern in more densely developed areas. It could also provide fixed circulator routes in areas of medium level density. Route deviation or demand-response services could be provided in less densely developed areas. Employment center shuttles from transit centers could serve individual employment centers. Connector and community-based service routes might be operated with 25-passenger small buses or 12-passenger van cut-a-ways, depending on level of demand (*5*).

The proposed plan is ambitious, and would result in a substantial increase in the agency's operating expenses

FIGURE 5 KCATA MetroFlex schedule with pictograph of 12-passenger van cut-a-way (note MetroFlex logo).

FIGURE 6 KCATA small bus service schedule with pictograph of 30-ft bus.

FIGURE 7 KCATA large bus service schedule with pictograph of 40-ft bus.

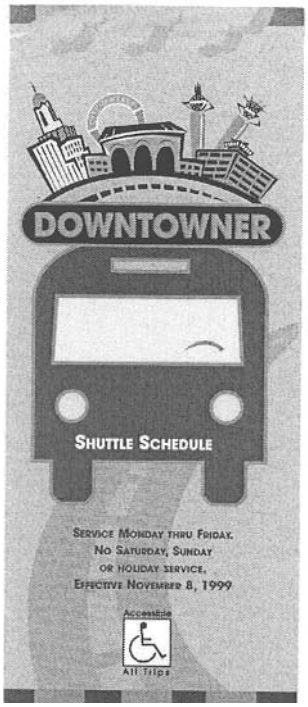

FIGURE 8 KCATA Downtowner schedule with Downtowner logo.

(+89 percent) and require important new sources of funding. Irrespective of the outcome in the Kansas City area, such efforts illustrate how the availability of a more comprehensive array of tools, in particular using small buses of different sizes and with different cost structures, allows for much greater flexibility and creative thinking in the design

of transit service. It remains a challenge to determine how the various potential service design concepts should evolve, which concepts should be used under which circumstances, how to measure cost-effectiveness, and how to ensure consistency and coherence for the customer.

A final issue concerns *the organization of the dispatching function for flexible services*. Currently, customer requests concerning the MetroFlex services are directed to a central dispatch telephone number. KCATA employs two dispatchers to handle four MetroFlex routes and has no special software to support their function. This limits the ability to introduce new MetroFlex services. It also creates an extra layer of interpretation one step removed from the customers. The dispatchers are more distant from the customer, less familiar with the terrain and the specific limits for route deviations (e.g., is the address within the allowed one or two blocks off route), and do not always know if a specific customer has been picked up. Customers could contact the driver directly, but there is a reluctance for that option because of concerns over quality control. There are advantages and disadvantages to both approaches, but KCATA may consider decentralized dispatching in the future.

PORT AUTHORITY OF ALLEGHENY COUNTY

Background

In 1990, the Port Authority of Allegheny County, Pennsylvania, introduced a small bus service called Link, which used a subcontractor to operate small vans to provide service within several corridors in the Monroeville area, an outlying suburban community. This new service was a huge success and at its peak service carried 600 passengers daily. The Port Authority was forced to drop the program in 1991 after a court challenge on whether nonunion drivers could operate the Link vehicles.

In 1996, the labor contract negotiated with the union allowed for services using small transit vehicles (STV) operated by unionized Port Authority drivers, who would be paid at 65 percent of the top wage rate and drive leased vehicles. As a result, the Port Authority reintroduced the 28X Airport Flyer route. Initially it leased five 20-passenger buses from a local company. The route has proven popular and was carrying 1,650 passengers per day as of July 2000.

In December 1997, the Port Authority signed a new 4-year labor contract that defined the terms under which STVs could be deployed. The key conditions specified in the contract are summarized as follows:

- An STV is any transit vehicle with an original seating capacity of not more than 24 passengers.
- STVs may replace any existing fixed-route service as long as the number of STVs used in such service does not exceed 3 percent of the total number of large buses scheduled for service at peak-time operation for that pick.
- There is no limit on the number of STVs that may be used on new routes in low-density areas, provided that the new route is designed to supplement ridership on existing routes and does not replace existing fixed-route service.
- Operators after January 1, 1998, are hired at 65 percent of the top driver rate. The number of drivers that are paid at the 65 percent rate is determined by a formula defined in the labor agreement, as follows: the total number of STV vehicle-hours of service is divided by 40 (based on a 40-h work week), rounded up, and added to a fixed factor of 15 for platform adjustment. This number can change for each pick during the year.
- Although the number of drivers in the 65 percent pool is calculated based on the total STV hours, the routes are merged in the pick, and drivers at the 65 percent wage rate do not necessarily operate STVs. When the number of operators held at 65 percent exceeds the number defined in the previous formula, the excess number of operators will be moved by seniority into the first step (85 percent) of the regular driver pay progression by seniority.
- The STVs may be leased or purchased at the discretion of the Port Authority. The Port Authority maintenance employees are responsible for first echelon maintenance, defined as oil changes, fluid changes and/or additions, and lubrications. If the STVs are purchased, all other maintenance and repairs are done by Port Authority employees. If the STVs are leased, all other maintenance and repairs may be performed under contract or lease agreement.

Following negotiation of this contract, the Port Authority leased an additional 75 STVs, and introduced them into service, on both new and large bus replacement routes, starting in June 1998. By 2000, there were 30 routes using the 80 STVs.

Use of Small Buses

Route Conversions

As mentioned previously, the labor contract limits conversion from large bus to STVs to 3 percent of the number of large buses used in peak service at any given time. In the fall of 2000, there were 785 large buses scheduled for peak hour service. The number of STVs that could be used to replace large buses was, therefore, limited to 23 STVs. These were being used on 21 fixed routes, which were

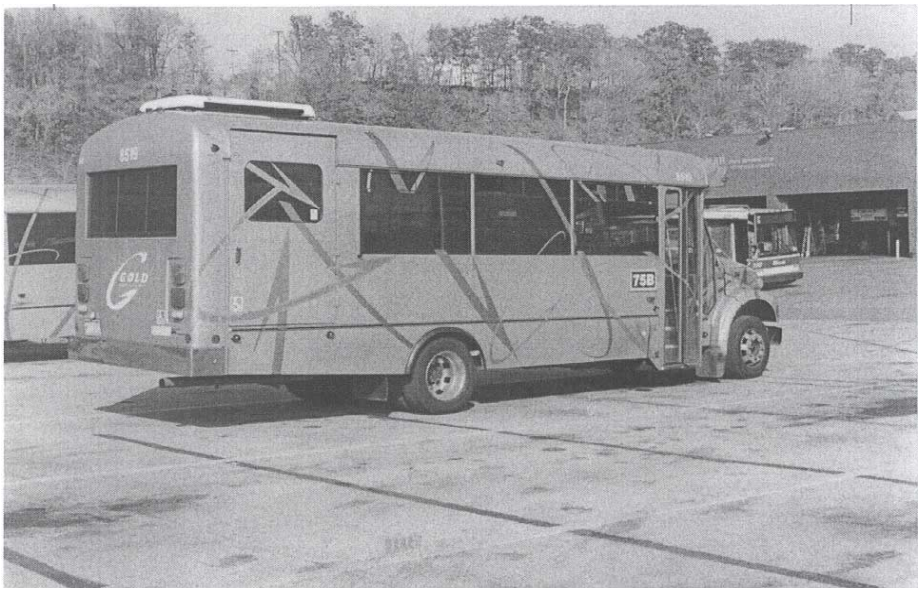

FIGURE 9 Port Authority 24-passenger STV.

primarily located in the more distant suburbs, although a few were being used in inner ring suburban areas contiguous to downtown Pittsburgh. The number of routes for conversion could vary for each pick.

The use of smaller buses on these routes was not identified on the schedules or on the system map. The Port Authority's STVs are 24-passenger buses, accessible to wheelchair users via a lift in the very rear of the bus (Figure 9). With the exception of the first five leased buses, all are painted a gold color and sport a "Port Authority Gold" logo that ties in with a corporate-wide image initiative. The converted routes are carrying on average approximately 15 passengers per vehicle hour, with a range of from 8 to 22 passengers per hour.

Airport Flyer (28X)

This was the original new route using STVs. It provides service by means of the West Busway from Oakland (home of the University of Pittsburgh and Carnegie–Mellon University), downtown Pittsburgh, and Robinson Town Center to Pittsburgh International Airport. It currently uses sixteen 20-passenger accessible buses with luggage racks. It has been extremely popular, carrying 1,650 passengers per weekday and operating mostly on 15- to 20-min headways on weekdays and 20-min headways on the weekend. The printed schedule mentions the size of the vehicle.

AIRCOR Routes (25A and 25D)

These routes were developed in cooperation with the Airport Corridor Transportation Association (ACTA). ACTA was developed in 1990 to manage the transportation needs of employers located in the Airport Corridor and Parkway West area, in the western outer area of the region. ACTA commissioned a planning study in 1997 to assess the demand and public transportation needs in the corridor. The two routes were subsequently negotiated with the Port Authority and introduced in June 1998. ACTA reimburses the transit agency 20 percent of the operational costs on a monthly basis.

The small buses allow easy access into office parks, shopping malls, and big box stores in the area. The two routes are operated on approximately an hourly basis, with half-hourly service in the core around Robinson Town Center, a major shopping area. Robinson Town Center is also a major transfer point where customers from the AIRCOR routes can transfer to the Airport Flyer to downtown or the airport, as well as a number of other routes. The AIRCOR routes are carrying approximately four to five passengers per vehicle hour. A distinctive AIRCOR logo is found on the printed schedules and on the STVs used on these two routes (Figures 10 and 11).

GOLDLINK Routes in Monroeville (75 A, B, C, D, E)

In June 1998, four routes using STVs were reintroduced to the Monroeville area, with a fifth route added in March 1999. The new routes serve the eastern outer areas of the region and provide close access to a variety of suburban senior centers, apartment complexes, and shopping centers, typical of a community bus-type service design (Figure 12). Routes are generally operated on an hourly basis and are carrying approximately five passengers per hour.

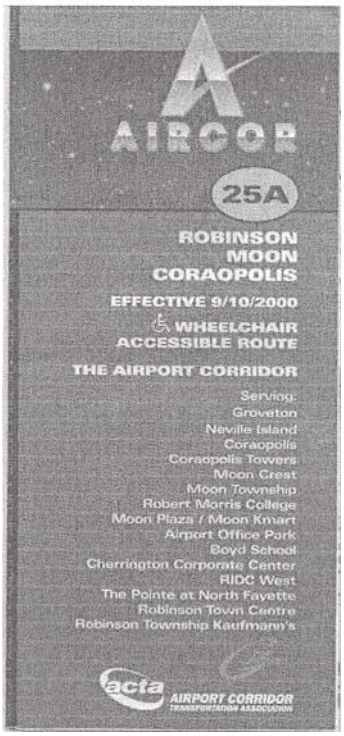

FIGURE 10 Port Authority Route 25A schedule with AIRCOR logo.

These routes received a distinctive name and branding, GoldLink, which is found on the printed schedules (Figure 13). This further extends the image-building initiative that was being promoted: The *Port Authority—Dedicated to a Gold Standard of Service*. In addition, the entire second order of leased buses was painted an all-gold color. However, to date, the GoldLink identity has only been used in the new Monroeville services and not for other new STV services.

Vehicle Considerations

One of the most interesting aspects of the Port Authority case study is the vehicle leasing arrangement. The following lists some of the specific characteristics of the arrangement:

- The vehicles are owned by a private contractor, but are leased to, and maintained for, the Port Authority under a 5-year contract.
- The vehicles are stored in a separate, enclosed designated area at the Port Authority garages.
- Port Authority maintenance employees are only responsible for fuel and fluid changes.
- The contractor performs all maintenance, including body repairs following accidents. Some minor repairs are performed in the separate areas where the buses are stored, but most are done at the contractor's own facilities.

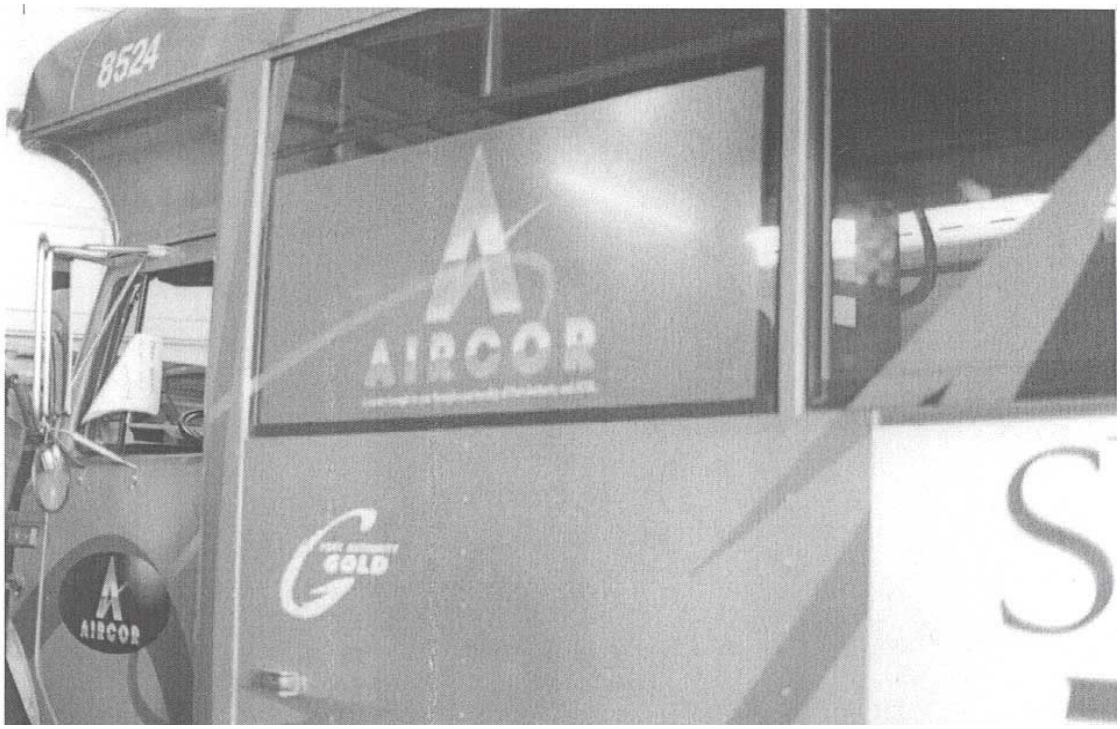

FIGURE 11 AIRCOR logo on Port Authority STVs.

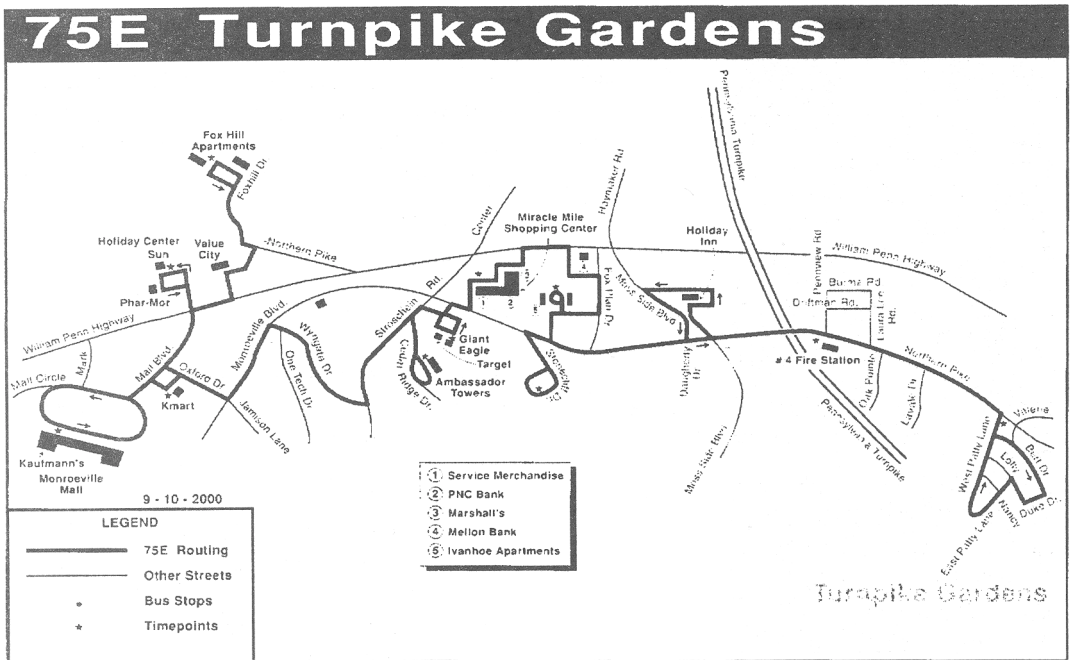

FIGURE 12 Route map for Port Authority 75E GoldLink service.

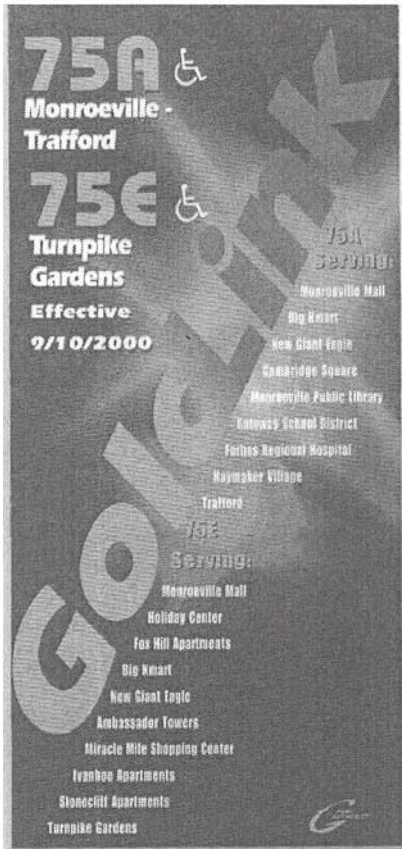

FIGURE 13 Schedule for Port Authority Routes 75A and 75E with GoldLink logo.

- The contractor sends the Port Authority a monthly lease and maintenance statement. Accident repairs and damage to vehicles are considered additional costs to the Port Authority.
- The contractor has 2 h to respond to a road call, 24 h a day, 7 days a week.

Port Authority staff feel that the contractor has worked diligently to fulfill the lease/maintenance contract arrangement and has provided a good level of service, at a very reasonable cost.

In terms of vehicle acceptance, the 80 vehicles operated for the Port Authority STV services are of a body on medium-duty chassis design and have had mixed acceptance from customers. The spring suspension makes for a hard ride and is not comfortable compared with large buses. In addition, the four-step entry is steep, which is difficult for seniors. As a result, for the next procurement cycle, the Port Authority is considering two types of small buses: one 10-year and the other a 7-year bus, similar to the current STV buses, except for one less step at the entrance (*6*).

Summary of Costs

The contracts for the STVs were negotiated in two rounds: an initial contract concerned the leasing and maintenance of the 5 initial buses, followed by a second contract 2 years later for an additional 75 buses. The lease and maintenance costs are higher in the second contract, but this probably reflects more accurately the realistic costs, based on the initial 2 years of experience.

TABLE 17
COST SUMMARY PER VEHICLE-MILE

Cost Item	First Five Mini-Buses ($/vehicle-mile)	Other 75 Mini-Buses ($/vehicle-mile)
Vehicle lease	0.427	0.655
Contract maintenance	0.272	0.390
Operator	2.274	2.274
Fuel and lubricants	0.075	0.075
Service labor	0.161	0.161
PM labor	0.025	0.025
Totals	3.23	3.58

Sources: Port Authority (*7,8*).

TABLE 18
COST SUMMARY PER VEHICLE-HOUR

Cost Item	First Five Mini-Buses ($/vehicle-hour)	Other 75 Mini-Buses ($/vehicle-hour)
Vehicle lease	5.22	8.01
Contract maintenance	3.32	4.76
Operator	27.82	27.82
Fuel and lubricants	0.920	0.920
Service labor	0.206	0.206
PM labor	0.307	0.307
Totals	37.79	42.02

Sources: Port Authority (*7,8*).

Tables 17 and 18 summarize the capital (lease), contract maintenance, and operating costs on a vehicle-mile basis and a vehicle-hour basis, distinguishing between the two contracts.

The National Transit Database (NTD) data of 1998 (*9*) places the costs cited in the tables in perspective, although they are not directly comparable, because overhead costs are not included. The total operating expense per vehicle revenue mile for Port Authority buses was $6.54 in 1998, and the total operating expense per vehicle revenue hour was $90.51.

Other Issues

Two additional issues are worth noting. The first concerns the *organizational effort required to manage and control a separate leased fleet*. Implementing this approach was challenging in several distinct ways. First, introducing a separate fleet, which the contractor not the agency maintained, created an institutional problem of ownership of the service. This responsibility did not fit naturally into the organization, and the STV fleet was at first something of an orphan. As a result, problems facing both maintenance and operations were difficult to address. It was not until the Manager of Special Services, in the Operations Department, was given clear responsibility for ensuring service quality that the problems were successfully addressed.

In addition, the concept of private contract maintenance inevitably caused labor stress, even though it had been agreed to in the labor contract. Several incidents occurred and, eventually, the buses were stored in a separate area outside of the garage property that included surveillance cameras. This arrangement also helped keep the private maintenance staff some distance from the unionized maintenance employees, which minimized direct conflicts. Those divisions where management took a proactive approach to these conflicts were more likely to ensure the quality of service to the customers.

At the same time, there was a steep learning curve for both the agency and the contractor, which required constant communication and the development of several new standard operating procedures and reports. From the start, they addressed several initial issues in order to adjust the vehicle technology, such as using higher quality tires for replacement, adjusting the heater valves, or boosting the alternators. These improvements are not unusual for a new vehicle, but it became more complicated because of the arms-length distance between the parties. Once the conflicts were addressed, new lines of communication between the agency and the contractor had to be established that all parties understood. Finally, these communications had to be formalized, through the development of standard invoice procedures, maintenance request reports, repair logs, etc. All of these challenges can be addressed positively, but they do require a strong and sustained effort from the transit agency's management.

The case study identified a second issue concerning the *lower wage rate for small bus drivers versus seniority*. As mentioned above, as of January 1998, new drivers hired by

the Port Authority were hired at a wage rate of 65 percent of the top driver rate. It generally takes 2 years to be promoted out of the 65 percent pool, at which point the first step of full progression is at an 85 percent level. Under the Port Authority agreement, all runs, irrespective of the size of the bus, are picked at the same time; they are not separated as in many agencies. This practice leads to an interesting situation. Driving an STV run is often viewed as a less onerous job, and senior drivers, therefore, often select the STV runs. As a result, drivers who are paid the lower wage rate, which was nominally linked to the driving of a smaller bus, rarely actually drive a smaller bus. The result is the complex formula described previously, which may help smooth the progression process.

SMART

Background

The Suburban Mobility Authority for Regional Transportation (SMART) in suburban Detroit uses small buses extensively for a wide variety of services. Within the city of Detroit, transit is provided as a municipal department. In the growing and highly auto-oriented suburbs of Detroit, support for transit has always been difficult to achieve, perhaps not surprising in the auto capital of the world. SMART was created in 1989 to replace the Southeastern Michigan Transportation Authority (SEMTA) and was given an institutional structure believed to be more workable. However, it received no local funding, and consensus among the three counties proved difficult to achieve. By 1992, SMART's financial situation had become dire, with massive service cuts and a growing debt load. It became clear that the agency would only survive with some form of dedicated tax.

Michigan's charter does not allow for a sales tax, and state gas taxes are dedicated 90 percent to highway construction and maintenance. State Act 196 allowed for the possibility of a property tax (dedicated transit millage), but gave the municipalities the right to opt out through a two-step process. Local councils would first decide whether or not to put the vote on the ballot for their residents, and if such a decision were made it would have to be voted on. This proviso essentially allowed the city of Detroit to not participate in the levy, because the millage would further affect an already difficult economic situation. However, it also gave individual suburban municipalities the right to opt out of the dedicated tax.

This legislation created difficult conditions for a vote, and passage was viewed as unlikely when the proposed dedicated millage tax support for SMART was placed on the ballot in 1995. In the meantime, SMART's leadership had concluded that the vote would only succeed if the agency totally reinvented itself, community by community, shedding past policies, and advocating the benefits of its renewed approach. Therefore, it made a number of creative decisions in rapid succession, including

- Making services more understandable to users and elected officials;
- Orienting the service to the suburban job centers in recognition of where the growth was occurring;
- Totally redesigning services to create a comprehensive network of suburban crosstown routes, so that all suburban arterials would have service, and thereby connect all important employment and shopping centers;
- Creating new concepts of "Community Transit" to enhance mobility for seniors and the disabled; and
- Implementing innovative services that address suburban land-use realities and mobility needs.

In addition, the agency would make efforts to work closely with the individual communities that supported SMART (by opting into the millage levy), in an effort to change existing perceptions about the agency's approach. In particular, municipalities would be given much more control over the types of service they wanted in their own community through a "Community Partnership Transit" program.

One critical decision was to invest in small buses, and an initial order of sixty-four 29-ft buses was placed. These buses would be used to implement the new crosstown services and would help convey an "efficient" image for the agency by reducing the "empty large bus syndrome." In addition, the small buses were influential in helping to convince reluctant shopping mall owners to allow SMART buses on their property, including the development of a set of new transfer hubs. The emphasis on small buses was even carried into the colors on the transit maps, where services with large buses were in blue, while other colors indicated the new services with small buses.

The agency's leadership and staff made extensive efforts to carry the message of the "new" SMART to each of the municipalities. In the end, 76 of the 129 municipalities in the region, "opted in" in the 1995 vote to provide the millage levy to support transit in SMART's service area. Thus, SMART could implement a wide-ranging family of services, developed in cooperation with local desires and assistance. All services involved the use of small buses.

Use of Small Buses

SMART offers the following full family of services to its customers in the suburban areas of metropolitan Detroit, all of which involve the use of small buses:

FIGURE 14 SMART 29-ft bus in downtown Detroit.

- Regular Fixed Linehaul Routes,
- Park & Ride (four routes to downtown Detroit and one reverse commute),
- Job Express (four areas),
- Flexible Route Service (two areas),
- Dial-a-Ride (six communities),
- Community Transit,
- Community Partnership Transit,
- North Macomb Community Transit, and
- Pontiac Rainbow Service.

SMART transports approximately 35,000 passengers per day on its linehaul service, and 2,000 passengers per day on the various paratransit services.

Regular Fixed Linehaul Routes

Although SMART still operates a few radial-based trunk lines into downtown Detroit (Figure 14), the importance of these routes has decreased dramatically over the last decade, given the changes in economic and land-use patterns in the region. Downtown Detroit now only represents a small portion of the regional economic activity and has lost most of its retail base to the suburbs. As a result, several of these radial routes have been transformed into reverse commute routes taking residents from the city to industrial jobs in the suburbs, and connecting to the job express routes described later in this section.

As mentioned previously, crosstown routes in the suburbs are the core of SMART's current family of services. Many of these were put in place in the early 1990s using the newly acquired 29-ft buses and creating a grid of services along arterials that connected all the major job centers and shopping malls in the suburbs. Ridership has grown to the point that it is increasingly difficult to serve these routes with the small buses, and a new generation of large buses (35 and 40 ft) is now being acquired.

Park & Ride

The same regional trends that affected trunk lines oriented to downtown Detroit resulted in the dramatic reduction of Park & Ride routes. In 1984, the Park & Ride routes were SEMTA's, the precursor of SMART, most productive. Today, they are the least productive, frequently carrying fewer than 20 passengers per trip using small buses. SMART still operates four Park & Ride routes to downtown Detroit, but also operates one reverse commute Park & Ride that serves the Daimler Chrysler Technology Center and connects with two Job Express routes, described here.

Job Express

Job Express services exist in four major suburban employment areas and uses small buses to transport riders directly to their work sites during peak hours only. Passengers ride fixed-route buses to a Job Express pick-up point, and transfer to a waiting small bus that takes them to their place of employment. An additional 50-cent fare is

charged. Return pick-ups can either be scheduled with the driver or by calling a 1-800 number to contact the dispatcher. Fifteen of SMART's 57 fixed routes connect with the 4 Job Express areas and are clearly promoted as such.

The agency believed that it needed a more flexible type of operation to serve suburban areas where fixed-route services would be inefficient. They are currently carrying two to four passengers per vehicle hour, and acceptance is growing slowly. The goal is to achieve a target of four passengers per hour. A point of interest is that Job Express had also been tried unsuccessfully in Royal Oak. In this case, the old suburban downtown area is relatively compact, with sidewalks making walking feasible and acceptable.

SMART and its predecessor SEMTA have had a long history of providing local Dial-a-Ride, primarily for the benefit of seniors and the disabled. The Job Express service, however, is aimed at a more mainstream clientele, in particular, work trips to auto plants. Some resistance occurs from existing paratransit drivers who have experienced some difficulty adapting to this new type of service and its different mode of operation and clientele.

Flexible Route Service

The Job Express is a peak-hour flexible employment shuttle serving narrowly defined areas of employment concentration, such as the Daimler Chrysler Technology Center. Another type of service, entitled Flexible Route Service, was implemented to serve a broader area surrounding a corridor where an all-day flexible service was needed to serve not only work trips, but also shopping and other types of trips. The first of these was developed along Groesbeck Highway. Groesbeck Highway is a high-speed roadway that does not lend itself comfortably to transit service. The speed of the vehicles traveling on Groesbeck creates a safety concern with respect to rear-end collisions into stopped buses. It also has few pedestrian amenities and points to cross. Finally, only a portion of the considerable light industry employment in the corridor is located directly on this highway.

A limited Jobs Express service was first implemented in this area, and its success created a core service on which to build. Under the Flexible Route concept, the area to be served was considerably expanded, and four timepoints defined. One was at a transfer to a major trunk route in the southern part of the area, another at a shopping mall, a third at a combined major transit hub and shopping mall in the heart of the area, and a fourth at the County Service Center with a transfer point at the northern end of the area. Passengers can board the small bus within the defined service area at the defined timepoints, or by calling SMART to arrange for pick-up at any other location within the service area. Pick-ups can be within a window of plus or minus 10 min of the arranged time. The bus runs between the scheduled timepoints, with a 5-min dwell time at timepoints, allowing coordinated connections to other trunk or crosstown routes, but it deviates along the corridor to make drop-offs or pick-ups.

A second Flexible Route Service was established in the city of Troy, which serves the area between two scheduled timepoints, one located at a major transit hub and mall in the south and another at a mall in the north. The route runs between these two scheduled timepoints, dropping off customers who had boarded at the timepoint, and collecting those who had pre-arranged pick-ups, thereby providing a flexible service to a variety of employment centers and shopping facilities in this area.

An interesting aspect of the Flexible Route Service concept is the unique fare policy: Passengers boarding at the designated timepoints pay the standard SMART fixed-route fare ($1.50 plus $0.25 for transfer), but those boarding at other locations pay the slightly higher Community Transit fare ($2.00 plus $0.10 for transfer).

Dial-a-Ride

As mentioned previously, SMART and its predecessor SEMTA have had a long history of providing local Dial-a-Ride service, primarily for the benefit of seniors and the disabled. These services are designed to provide immediate local travel within the specific communities where they are available. Customers call dispatch and are usually picked up within 45 to 90 min from time of request. Customers pay the Community Transit fare. Dial-a-Ride services were more prevalent in the past, but have often been replaced by the advanced reservation services, described in the following sections. It has become infeasible over time to maintain acceptable levels of service with a single bus, depending on the size and traffic conditions in the community. As a result of the new institutional structure in the region, each community now decides the type of local service they desire and then negotiates with SMART. There are currently six suburban communities that still offer Dial-a-Ride service.

Community Transit

Community Transit service is a curb-to-curb advanced reservation service, typically operating 24-ft, 17 passenger buses (Figure 15), designed to meet many of the special needs of people who cannot access SMART's regular fixed-route service. General reservations can be made up to 2 days in advance; medical trips need to be made 4 days in advance. These services are organized in zones, and cross-

FIGURE 15 SMART'S 24-ft Community Transit bus.

boundary trips require a transfer. ADA eligible customers are accommodated on the Community Transit services, but are provided a level of service that meets the ADA requirements. This accommodation creates operational constraints, because not all municipalities have this service.

Community Partnership Transit

The state of Michigan makes available to municipalities "Municipal Credit" funding that can only be used for the operation of community-based public transportation services. Examples include operating a local transit bus to provide access for seniors to parks and recreation programs, or to buy pre-paid SMART tickets for distribution to groups chosen by the municipality (e.g., seniors). This funding cannot be used for capital purchases of the vehicles themselves. There is also state and federal funding available to municipalities for specialized services by private nonprofit operators. The state requires that there be regional coordination for the services provided under these funding programs. SMART acts as the administrator of these programs for all municipalities in the region and ensures the regional coordination function.

As part of its effort to maintain positive relationships with those municipalities that have opted in to the regional transit millage, and to create an incentive for other municipalities to consider opting in, SMART has developed a Community Credits funding program. This program is essentially a tax rebate to those communities that have opted in, and supplements the Municipal Credits program. It has two important differences: It is only distributed to those municipalities that have joined, and can be used for operating or capital purposes. This, in turn, can help to leverage additional federal capital funding for buses for local services, because the program can be used as the local funding match.

These programs have been well received and can be used to fund the type of local service desired by the municipality. This service could be the aforementioned Dial-a-Ride or Community Transit service operated by SMART. It can also be used for implementing experimental service designs such as the Pontiac Rainbow or North Macomb services described below.

Approximately 50 of the 129 communities have used this SMART Community Credits funding to support their own local bus service within their communities, and typically they operate one or two vehicles. Since the passage of the 1995 millage vote, more than 70 small buses have been purchased for such municipally operated Community Partnership Transit services. The purchase of the vehicles is administered by SMART, and three types of vehicles have been purchased for the municipalities: 24-ft buses with 17 passengers, 21-ft buses with 10 passengers, and 7-passenger vans. All vehicles have SMART's Community Transit paint scheme, but with the additional wording, "In Partnership with Local Communities."

In addition, SMART has a team of Community Transit analysts that support the Community Partnership communities, helping them design, organize, or refine their service. Current efforts are focusing on the use of advanced scheduling software to improve the coordination between these local services.

North Macomb Community Transit

One special Community Transit service merits highlighting. North Macomb is a mostly rural area on the northern fringe of the region, but where all 27 municipalities have opted in to the service. The original intent was to offer the standard advanced reservation Community Transit service

operated by SMART. However, each community chose to have a scheduled bus stop in their community. A service design was thus developed in an effort to meet local expectations, involving a scheduled Flexible Route service using small buses, but with a large number of timepoints. Following a union challenge that this constituted large bus service, it was agreed that it would be a hybrid service design, and that the agency would consider conversion to large bus service if either of the following route productivity criteria were met: 18 passengers or more per trip or 10 passengers or more per hour. Service quality was, however, difficult to maintain under such a design, and the service has been converted to the advanced reservation Community Transit type of service.

Pontiac Rainbow Service

Finally, a more sophisticated variation of the Flexible Route Service was implemented in Pontiac and Auburn Hills in 2000. Pontiac is an older, denser city surrounded by the region's lower density suburban growth. It combines an older core with considerable unemployment and recent urban renewal efforts, surrounded by major employment centers (such as the Daimler Chrysler Technology Center) that have been difficult to access by transit. The agency designed an innovative approach to address this unique situation and its related mobility requirements.

The Rainbow Service divides the area into six color-coded overlapping bus zones, each serviced by one bus operating between scheduled timepoints, but providing flexible service in between the timepoints. The timepoints are located at shopping malls (Figure 16), hospitals, community colleges, human service agencies, the Phoenix Center in downtown Pontiac, etc. The schedules of the six buses are coordinated at the timepoints, with two to four buses meeting at each timepoint to facilitate transfers between the Rainbow buses, as well as with linehaul routes. Passengers can use the service in three different ways: customers can board the bus at the timepoints and be dropped off anywhere within the zone of that bus; they can make an advance reservation to reserve a ride (2 days in advance for general trips and 6 days in advance for medical trips); or they can call dispatch to request same-day service, although same-day service is not guaranteed. The Rainbow Service is an effort to combine a variety of attributes derived from the Flexible Route, Advance Reservation Community Transit, and Dial-a-Ride service design concepts. The fare policy is the same as the Flexible Route service, with the fixed-route fare paid for boarding at timepoints, and the Community Transit fare paid at other pick-up locations.

Vehicle Considerations

The SMART active fleet is composed of large buses and small buses. Table 19 provides information on some of the characteristics of these fleets.

SMART has found that the 29-ft small buses are less expensive to operate, especially from the point of view of fuel economy. However, customers dislike them because the ride is uncomfortable given the truck-based spring suspension.

FIGURE 16 SMART Pontiac Rainbow Service timepoint.

TABLE 19
SMART BUS FLEET

Manufacturer Model	Service Life	Length (feet)	No. of Seats	No. of Vehicles	Year(s) Purchased
		Large Buses			
Nova Bus RTS	12	40	43	145	1990–1995
Gillig Phantom 40	12	40	48	2	1992
Gillig Phantom 35	12	35	37	23	2003
Total Large Buses				*170*	
		Small Buses			
Gillig Phantom 30	12	30	28	22	1992
Blue Bird CSRE 3700	10	32	26	20	1999
Champion Centurion	7	29	22	83	1996
Champion Centurion	7	29	24	20	1994–1996
Champion Centurion	7	25	18	5	1994
ElDorado–National Aerotech	5	21	11	13	1999 & 2000
ElDorado–National Aerotech	5	24	19	135	1999 & 2000
Champion Challenger	4	24	19	151	1994–1997
Champion Crusader	4	21	13	26	1994–1997
Ford Club Wagon	4	19	8	8	1998
Dodge Caravan	4	19	8	5	1996
Dodge Minivan	4	19	8	1	1996
Ford Maxivan	4	19	8	2	1996
Total Small Buses				*491*	

Source: APTA (*2*).

In addition, as a result of the suburban nature of the service, with its emphasis on commuter trips, the service has always had a high peak-to-base ratio. In SEMTA's time, the peak-to-base ratio was three. With the new system design under SMART, the ratio is reduced somewhat to around two, but is still high. As a result, SMART still operates a number of peak only routes, which also involve considerable interlining. SMART staff have found that the capacity of the 29-ft bus makes it more difficult to schedule and assign in their highly interlined operation. In addition, ridership on the crosstown routes has grown to the point to justify higher capacity buses. Finally, although small buses were useful at first in order to persuade reluctant shopping mall owners to allow access to their malls, the relationships are now well established, and this is no longer an important consideration. As a result, SMART has placed an order of 280 35- and 40-ft buses to replace the current generation of 29-ft buses used on fixed-route crosstown routes.

SMART remains committed to the use of smaller buses for the various paratransit and flexible services. They are, however, moving towards greater standardization of the smaller buses as well. SMART will buy only 24-ft buses for its paratransit and community transit services, but will continue to acquire the three sizes of vehicles (24 ft, 21 ft, and vans) for the Community Partnership Program.

Other Issues

Union representation is an issue for SMART. Currently, SMART has two unions representing its drivers: The Amalgamated Transit Union represents the linehaul drivers and the Teamsters represent the paratransit drivers. They have different wage scales with a differential on of approximately $2–$3 per hour. However, the actual criterion distinguishing the boundaries of representation is not based on type of service, but on the size of the vehicle. Work on buses that are 30 ft or less in length is represented by the Teamsters. This created an issue when 29-ft buses were acquired for linehaul service; however, a special dispensation was agreed upon. The experience at SMART does raise the larger issue of whether union representation should be based on vehicle size or type of work.

A second issue relates to the use of technology to improve the coordination of innovative services using small buses. Although the Community Partnership Transit services are well appreciated locally and help to involve the communities in the design of the services, the services are fragmented, with each having its own reservation telephone number. The agency believes that these services, and especially their customers, would benefit from greater coordination between the different services. As a result, SMART is exploring the potential use of advanced technology to address this issue. The previous version of the paratransit scheduling software has been upgraded to a more sophisticated version, and an unlimited license agreement has been negotiated with the supplier. The objective is to build an airline-type reservation system that could integrate and coordinate the advanced reservations made for the various Community Partnership services and SMART's Community Transit service. It is hoped that, ultimately, one number would be available for reservations, as well as a single integrated scheduling activity delivered on a myriad of providers.

LAKETRAN

Background

The Lake County Regional Transit Authority (LAKETRAN) is located east of Cleveland, Ohio, along Lake Erie, and has been one of the leaders in the use of small buses since its beginning. LAKETRAN was created in 1974 to develop public transportation service in Lake County following the demise in 1962 of the previous private company and years of unsuccessful attempts to reintroduce service in the county. To facilitate the obtaining of federal funding, in 1997 LAKETRAN assumed responsibility for the existing private nonprofit Special Transportation Service (STS), which provided transportation for the elderly and the disabled. STS became the operational arm of LAKETRAN (*10*), and from that point on, serving the elderly and disabled was at the heart of LAKETRAN's mandate.

STS operated a dial-a-ride service, using a number of vans and minibuses. The LAKETRAN board knew that a tax levy would be necessary to acquire new vehicles and enhance the service being provided. A tax levy proposal was put before the voters four times between 1975 and 1980, but failed each time. The very nature of the sociodemographics and land use in Lake County made this an extremely difficult proposition. The county, with 224,000 residents spread over 232 square miles, has an extremely low population density (under 1,000 per square mile) (*11*). In addition, the land use ranges from low-density distant suburbs closer to Cleveland to pure rural areas in the eastern portion of the county. With good highway access into Cleveland, and no concentrations of urban population, Lake County is extremely auto-oriented, which explains the difficulty in convincing voters to pass the levy.

In 1979, the board hired a full-time administrator who worked with the board and its staff to implement a number of initiatives in order to pursue a transit option in Lake County. These initiatives included

- Changing the organization's name to LAKETRAN,
- Implementing a new logo and identity to clearly distinguish it from the adjacent and much larger Greater Cleveland Regional Transit Authority (RTA),
- Acquiring two 30-ft buses in 1985 for the first fixed-route service,
- Contracting for Park and Ride commuter service into Cleveland,
- Fully taking over the STS service and assets, and
- Leasing a garage facility.

By 1987, LAKETRAN had set up a skeleton county-wide public transit system without a dedicated source of revenue. However, voters now recognized LAKETRAN and were able to distinguish it from Cleveland's RTA (*10*). Market research showed that voters supported the concept of a tax to help the elderly and the disabled, and LAKETRAN's board went on record that 80 percent of its revenues would be devoted to the paratransit service. The voters approved a 0.25 percent sales tax in May 1988, giving LAKETRAN a strong mandate and the means to expand service.

LAKETRAN implemented a number of initiatives over the following years. In 1988 it ordered 18 vans to replace the aging STS vehicles. Twenty-eight more small buses were ordered in 1989. It acquired paratransit scheduling software and hardware and hired drivers, dispatchers, schedulers, and phone operators. These combined efforts helped to improve and expand the Dial-a-Ride paratransit service. In addition, used coaches were acquired to expand the Park and Ride commuter service. In 1989, four low-floor vehicles were added to the fleet that allowed for two new intracounty fixed routes. The rapidly expanding service had overgrown the capacity of the existing facility, and a new garage was built in 1990 and opened in 1992. Additional vehicles were acquired in 1991 and 1992, and all services continued to grow, although the fixed-route service was only being operated on an hourly or 2-hour headway.

The initial tax levy had been passed for a specified 6-year period and needed to be revoted in 1994. An extensive campaign was organized, emphasizing, in particular, the benefits of the Dial-a-Ride service that was being provided to many social service agencies and riders with special needs. Staff and board members made extensive presentations to social clubs, organizations, and municipal governments in an effort to seek support for the transit tax renewal, and were aided by an independent group called Friends of LAKETRAN. The renewal, passed by better than two to one, was for a 10-year period. This vote allowed for the expansion of the Dial-a-Ride, commuter Park and Ride, and additional fixed-route transit services and allowed the fleet to keep pace with demand. LAKETRAN also expanded the garage, including a compressed natural gas fueling station. Today the fleet stands at 100 buses, of which 60 are body-on-light-duty chassis (BOLDC) buses used in paratransit service.

Use of Small Buses

As mentioned previously, the starting point and continued core of LAKETRAN's operation is the use of small buses for the LAKETRAN Dial-a-Ride service. As a result, contrary to the ADA mandated services, which only require that service be provided to residents living within three-quarters of a mile of a fixed-route service, LAKETRAN's Dial-a-Ride is available to all county residents. As described in LAKETRAN's literature, "Dial-a-Ride is a door-to-door, assisted transportation system for all Lake

FIGURE 17 LAKETRAN Dial-a-Ride buses (driver side).

FIGURE 18 LAKETRAN Dial-a-Ride bus (curb side).

County residents. It will pick you up at home (or another origin) and drop you off at work, the doctor, or any other destination in Lake County." All Lake County residents are eligible, with special emphasis on senior citizens and the physically challenged. It operates using 23-ft buses (see Figures 17 and 18), Monday through Friday, 6:00 a.m. to 9:00 p.m., and Saturday, 10:00 a.m. to 6:00 p.m. Reservations are made from 2 to 10 days in advance, through a central dispatch service. Scheduling of trips is computer assisted. ADA-eligible customers can make their reservations with only 24 hours advance notice.

Another service, the Cleveland Medical Service, is also operated using small buses. It involves an advance reservation service that picks up residents anywhere in the county and delivers them to any of the four major hospitals or medical facilities in the Cleveland Circle area of Cleveland. This service operates every weekday. In addition, residents can travel to any other medical facility in Cuyahoga County the second Monday of each month.

Despite the impressive growth in the fixed-route transit and commuter services implemented by LAKETRAN over the last 10 years, the demand-response services still represent 60 percent of the total fleet, carry 43 percent of the total ridership (approximately 1,200 passengers per day), and cover 42 percent of the passenger miles (*9*). Demand-response service remains the flagship service of the agency. In addition, LAKETRAN has maintained its historic close relations with the 17 social service agencies in the county. It has developed, in particular, a priority relationship with nine of these agencies, who fax their transportation requests to improve efficiency, receive priority in scheduling for their clients' trips, and are billed directly for these trips, so that the clients need not pay when boarding.

Using data from the 1998 NTD, Table 20 compares the bus and demand-response services of LAKETRAN. Drivers of the demand-response service are paid a lower wage rate than drivers of large buses, with a differential of $1 per hour.

TABLE 20
LAKETRAN'S DEMAND-RESPONSE AND BUS SERVICES

Characteristics	Demand-Response Service	Bus Service
Trips	315,097	424,172
Passenger miles	3,420,352	4,715,989
Trips per revenue hour	2.81	11.74
Total operating expense per revenue hour	$36.84	$58.67
Total operating expense per trip	$13.12	$5.00

Source: NTD (*9*).

In 1998, 80 percent of the demand-response service was comprised of seniors and the disabled; however, an increasing effort is being made to market to the general public. Annual customer surveys show an extremely high rate of satisfaction with the service. In 1999, 93 percent of customers on the demand-response service were satisfied with the service they received, with 96 percent satisfied with the fixed-route service. A 1998 Community Attitude Survey of Lake County showed that the following groups were the biggest supporters of LAKETRAN:

- Those who ride or know someone else who rides,
- Residents in the eastern portion of the county (i.e., the rural areas rather than the commuter basin for Cleveland),
- Senior citizens,
- Women, and
- Those with household incomes of less than $45,000 (*11*).

Ridership continues to grow for both services. For the first 6 months of 2000, demand-response service grew by 4.7 percent and fixed-route service by 8.2 percent when compared with the first six months of 1999. Indeed, growth for demand-response services presents a serious challenge for the agency. LAKETRAN staff monitors the percent of "stand-bys" (i.e., customers requesting same-day pick-up) that can be accommodated and uses this indicator as a measure of whether additional buses are needed. During the summer of 2000, for example, 96 to 100 percent of standbys were accommodated. The growth in the demand and in service provided has advantages. As demand and service grows, it expands the potential use of the service. For example, peak demand for Dial-a-Ride was traditionally during the mid-day to access seniors' homes and shopping malls, but a growing number of work trips, made possible by the growth in service, is creating new peaks of demand during the more traditional transit a.m. and p.m. rush hours. This increases the efficiency of the resources deployed, and the service now carries 2.66 trips per hour. However, expanding the resources available for the demand-response service remains a challenge.

The recently performed review recommended various initiatives to encourage riders to use the fixed-route service where more capacity is available. These included passenger assessment and education, the development of fare policies that encourage the use of fixed-route services, fostering greater recognition from the social service partner agencies, and more aggressive marketing of services (*11*). These initiatives must take into account the unique mandate of LAKETRAN's services and maintain a demand-response service that is available to all county residents as a key component of the agency.

These numbers and the discussion illustrate that LAKETRAN provides an efficient and well-appreciated service that operates in an extremely unfavorable transit environment. The area is a collection of small communities spread over 232 square miles, with no significant urbanized areas or dominant traffic flow patterns. Primary highways are oriented towards Cleveland, and secondary roads have grown into large signal-controlled arterials, requiring stop-and-go driving over long distances (*11*). LAKETRAN's ridership and cost characteristics are, therefore, all the more remarkable given the environment in which it operates.

Vehicle Considerations

LAKETRAN has pursued a policy of acquiring inexpensive 21- to 25-ft BOLDC vehicles that can carry 10 or 14 passengers and provide two or three wheelchair positions. The service life of these vehicles is 4 years or 100,000 miles. (Information on some characteristics of LAKETRAN's fleet is given in Table 21.) Recent purchase prices have been in the range of from $54,000 to $56,000, including air-conditioning, a wide lift, a good energy bumper, and cushioned seats. LAKETRAN operations are such that these vehicles reach 100,000 miles after only 18 months. However, they schedule replacement of these vehicles on a 3-year cycle, replacing 20 buses each year. This 3-year replacement cycle allows vehicles to be replaced before any major work on the body or air-conditioning (which occurs at approximately 250,000 miles), but while the vehicle still has some resale value. It should be noted that their experience shows that the engines last considerably longer. Recent resale value on the vehicles after 3 years has been approximately $3,000 to $6,000, up considerably from 8 years ago when it was approximately $800 to $1,000.

The small size of the vehicles offers considerable advantage in getting in and out of customer driveways in the rural portions of the county. It also facilitates maneuvering in shopping plazas and at hospitals with low overhangs. In addition, the size offers considerable fuel economy: 8–10 miles per gallon (mpg) for the small buses compared with 3–4 mpg for the large buses.

Customer acceptance of the buses seems to be generally good on the basis of a 1999 customer survey, which did not

TABLE 21
LAKETRAN BUS FLEET

Manufacturer Model	Service Life	Length (feet)	No. of Seats	No. of Vehicles	Years Purchased
		Large Buses			
Motor Coach Industries 102.73	12	40	47	19	1990, 1992, & 1998
Orion Bus Industries Orion V	12	40	47	4	1992
New Flyer Industries C35LF	12	35	31	12	1997
Total Large Buses				*35*	
		Small Buses			
Orion Bus Industries Orion I	10	30	31	3	1985 & 1990
ElDorado–National Aerotech 240	5	23	10	15	2000
ElDorado–National Aerotech	5	23	14	4	1997
Goshen Coach Sentry 1290	5	25	12	1	1996
Goshen Coach Pacer II	4	23	10	54	1997–1999
Supreme BS22	4	23	14	36	1994 & 1999
Coach & Equipment Phoenix	4	23	10	5	1995
Care Concepts mini van	4	18	4	1	1995
Total Small Buses				*119*	

Source: APTA (*2*).

identify any specific concerns or remarks related to the comfort of the vehicles. However, LAKETRAN staff acknowledge that the vehicles are built on a chassis with a spring suspension, which provides a poor ride quality. Agency staff believes that the situation may improve considerably with the new generation of smaller buses. These buses are larger, but their size is not unmanageable. The improved ride quality and interior design will make them more comfortable and subsequently more appealing to customers.

Other Issues

One issue raised by the LAKETRAN experience concerns the use of technology to improve efficiency in demand-response service. LAKETRAN acquired specialized paratransit software in 1989. In 1999, it pursued a system enhancement involving the combined use of more sophisticated software, computer-assisted communications with on-board mobile data terminals (MDTs), and automatic vehicle location (AVL). The objective was to use this combined technology to respond to standbys in a more effective and efficient manner. In response to a real-time request for service, the dispatcher would be able to consider information provided by two screens: The first screen would use the AVL information to identify buses close to the caller's location, while the second would use the rosters from the scheduling software listing scheduled pick-ups and drop-offs identify the direction of the bus. The ultimate objective would be to combine these two sources of information onto one screen, where the dispatcher could right click on a given bus icon to open the scheduled itinerary. This process is analogous to conceptual designs outlined in various research studies (*12,13*).

However, the experience to date has failed to successfully put such concepts into operation. There were difficult communication constraints, as well as reliability and software issues. The technology is not yet at the point of consistently delivering the required functions.

A second issue concerns the implementation of innovative hybrid service delivery concepts that would combine or coordinate the best features of both demand-response and fixed-route services in an effort to increase efficiency and effectiveness. LAKETRAN has been working with researchers at Ohio State University on the feasibility of new service concepts. In particular, a recent study (*14*) conducted a detailed assessment, using geographic information systems, of actual trip data and repeated travel patterns, in order to identify potential fixed routes that would be based around prime destination points of the Dial-a-Ride users and link the most frequent origins to these destinations, while minimizing the miles traveled. Such efforts are the logical next step for LAKETRAN, given its extensive experience with demand-response service, and may help to address the challenge of growing demand for the service.

CHAPTER FOUR

SMALL BUS TECHNOLOGY

A broad range of technologies is used in the manufacture of small buses. The technologies include modified vans, body-on-light-duty chassis (BOLDC; i.e., cut-a-ways), body-on-medium- and heavy-duty chassis, integral construction with front and rear engines, and semi-monocoque construction with rear engines.

A modified van is a standard van that may have the roof raised to accommodate the standing height of passengers and, generally, has the installation of a larger door to allow for the use of wheelchair lifts or ramps. A manufacturer separate from the van chassis manufacturer completes these modifications and/or conversions.

Body-on-chassis construction is a design feature and method of construction in which the chassis and body of the vehicle are built as separate units and joined together to form the completed vehicle. Separate companies in separate plants commonly build the chassis and body of the same vehicle. A BOLDC vehicle (sometimes referred to as a "cut-a-way") is a light-duty chassis joined to a metal or fiberglass body to provide more room than available in a typical van.

All of the 4-year service-life small buses are either modified vans or BOLDC vehicles. The gross vehicle weight ratings (GVWRs) for these BOLDC range from 11,000 to 18,000 lb. All of the 5-year service-life small buses are BOLDC vehicles with chassis that range from 11,000 to 19,000 lb in GVWR. A considerable overlap in the GVWR is evident for these two classes of buses.

The chassis for body on medium- and heavy-duty chassis construction generally have heavy frame rails to which the body is attached. School buses and most single-unit medium and heavy-duty trucks are examples of body-on-chassis vehicles. The bodies are typically larger and stronger than those used with the light-duty chassis.

Most of the 7-year small buses are body-on-medium-duty chassis (BOMDC) vehicles with chassis that range from 13,000 to 24,000 lb. At this time, only one 7-year bus is available using integral construction with a rear engine and a GVWR of 13,500 pounds.

Integral (or integral space-frame) construction is a vehicle design feature and method of manufacture in which a single structure serves as both the chassis and body of the vehicle. Some manufacturers use the terminology of integral space-frame to eliminate the confusion between integral and semi-monocoque design and construction. An important advantage of integral construction is its greater rigidity-to-weight ratio, which permits a stronger body with a larger seating capacity for a given weight than body-on-chassis construction. Lower floor heights may also be easier to achieve, because the heavy chassis rails associated with body-on-chassis construction are not necessary. Some 7- and 10-year and many 12-year small buses use integral construction technologies.

Monocoque construction is a vehicle design feature and method of manufacture in which the outer skin of the vehicle body carries all or a major part of the structural stress. Airplanes and some automobiles use monocoque or semi-monocoque construction technologies. Semi-monocoque construction differs from monocoque in that the outer skin is reinforced with structural members, such as rectangular tubing, channels, or other shaped members. Some 12-year small buses are semi-monocoque vehicles.

The FTA provides a convenient classification method for small buses: five service-life classes. Because all vehicles purchased with federal funding assistance must first be tested at the Altoona Bus Testing Center (ABTC), an examination of the bus models that have been tested provides information on which small bus models are eligible for federal funds. Table 22 provides a breakdown of 64 small bus models that have been tested through 2000 by service-life classification. Because a manufacturer model series may have several lengths and options, the number of alternatives available to transit agencies is much greater than 64. Table 22 does not list the modified vans that have been tested because they are used primarily for paratransit service. In addition, some small bus models reported in the User survey fleets have not been tested at the ABTC. These models had been in revenue service prior to the legislation requiring bus testing and do not need to be tested.

TECHNICAL DESCRIPTIONS

There are a number of ways to classify small buses. Classification schemes use the number of seats, bus lengths, service life, GVWR, and costs (*16*). For this study, the most appropriate classification seems to be by service life. An interesting relationship exists between vehicle service life and GVWR, as shown in Table 23. GVWR is a rating of the vehicle design maximum weight for the combined

TABLE 22
SMALL BUSES TESTED AT THE ALTOONA BUS TESTING CENTER (through 2000)

Small Bus by Manufacturer and Model				
4-Year	5-Year	7-Year	10-Year	12-Year
Allen Ashley Pioneer	Cummins Dodge Ram	Advanced Bus Industries MVS 25	Blue Bird QBRE	Champion Contender
Braun Enter Van	Diamond DC Series	Advanced Vehicle Systems AVS 22	Blue Bird CSTS	ElDorado–National E-Z Rider
Champion Crusader	ElDorado–National Aerotech 240	Champion Defender	Champion So Lo	Flxible Metro 30
Champion Challenger	ElDorado–National Aerotech 200	Champion CTS	Champion Contender	Gillig 29' Low Floor
Coach & Equipment Phoenix	Glaval Universal	Champion Centurion	Coach & Equipment Condor	New Flyer D30LF
Creative Carriage ITV	Girardin MB Series	Chance RT-52	ElDorado–National Transmark RE	Orion Bus Industries Orion II
Diamond VIP 2500	Goshen Coach Sentry	ElDorado–National Escort FE		Orion Bus Industries Orion V
Federal Ford Shuttle	Metrotrans Classic	ElDorado–National Escort RE		
Freedom One Low Floor Mini Van	Starcraft Allstar	ElDorado–National ELF		
Girardin Futura		ElDorado–National Aero Elite		
Goshen Coach Pacer		Gillig Spirit		
Goshen Coach GCC II		Goshen Coach Sentinel		
National Mobility MPV		Glaval Concord		
Ricon Activan		Metrotrans Eurotrans		
Supreme Startrans		Startrans BSSN		
Supreme Low Floor Van		Supreme PS		
Supreme BSGP		Supreme Senator		
Turtle Top C26		Thomas Built Bus BB 365		
World Trans (Collins) Diplomat		Thomas Built Bus Vista		
World Trans (Collins) Royal Series		World Trans AT Mid Bus		
		World Trans (Collins) 3000		

Source: ABTC (*15*).

TABLE 23
GENERAL RELATIONSHIP OF SMALL BUS SERVICE LIFE AND GVWR

	SAE Classification [GVWR (lb)]						
Small Bus Service Life	6,001–10,000	10,001–14,000	14,001–16,000	16,001–19,500	19,501–26,000	26,001–33,000	33,001 +
4-year		Xxxxxxxxxx					
5-year		xxxxxxxxxx	x	x			
7-year			Xxxxxxxxxxxxxxxxxxxxxxxx	.x	x		
10-year					xxxxxxxxxxxxxx		
12-year						xxxxxxxxxxxxxxxxxxxxx	

weight of the vehicle and load. It is an indicator of the strength and durability of the vehicle. As expected, the vehicle with a higher GVWR generally has a longer service life. However, there is considerable overlap in GVWR for the 4-, 5-, and 7-year vehicles, as well as the 10- and 12-year vehicles. The bus manufacturer makes the decision of at what service-life category their bus is to be tested at the ABTC. The major difference is the length (number of miles) of the durability test. Table 23 shows that some small bus manufacturers had models tested for a service-life category when their vehicle had a much higher GVWR than other buses in that service-life category.

TABLE 24
EXAMPLES OF 4-YEAR SERVICE-LIFE SMALL BUSES

Characteristics	Bus 1	Bus 2	Bus 3
Lengths (feet)	25	20.9	21, 23, 25, 27.5
No. of seats*	16	8	8, 12, 15, 20
Entrance height (in.)	11–12	12	10.3
Entrance height kneeled (in.)	No kneeling	No kneeling	No kneeling
No. of steps to floor of bus	3	3	3
Type of suspension (spring or air)	Spring	Spring	Spring
No. of doors	1	1	1
Turning radius (feet)	31	25.2	25.3–35.75
GVWR (lb)	14,050	10,700–11,500	11,500–14,050

Sources: Small Bus Manufacturer's Questionnaire and Technical Sales and Product Information Literature (*17*).
*Maximum number of seats with floor plan meeting ADA requirements.

TABLE 25
EXAMPLES OF 5-YEAR SERVICE-LIFE SMALL BUSES

Characteristics	Bus 1	Bus 2	Bus 3
Lengths (feet)	23.2 and 24.8	25.8	30.3
No. of seats*	12 and 16	16	26
Entrance height (in.)	11.5	10.4	12
Entrance height kneeled (in.)	No kneeling	No kneeling	No kneeling
No. of steps to floor of bus	3	3	3
Type of suspension (spring or air)	Spring	Spring	Spring
No. of doors	1	1	1 or 2
Turning radius (feet)	26.8 and 31.5	33	29.3
GVWR (lb)	14,050	14,050	19,000

Sources: Small Bus Manufacturer's Questionnaire and Technical Sales and Product Information Literature (*17*).
*Maximum number of seats with floor plan meeting ADA requirements.

TABLE 26
EXAMPLES OF 7-YEAR SERVICE-LIFE SMALL BUSES

Characteristics	Bus 1	Bus 2	Bus 3
Lengths (feet)	28, 30.9, 33	25	26.5
No. of seats*	28	19	22
Entrance height (in.)	10.5–12.5	11	9.5
Entrance height kneeled (in.)	No kneeling	No kneeling	No kneeling
No. of steps to floor of bus	4	3	3
Type of suspension (spring or air)	Spring	Spring	Spring
No. of doors	1 or 2	1	1 or 2
Turning radius (feet)	27–31.1	—	24
GVWR (lb)	19,000	14,800	21,440

Sources: Small Bus Manufacturer's Questionnaire, ABTC reports (*15*), and Technical Sales and Product Information Literature (*17*).
*Maximum number of seats with floor plan meeting ADA requirements.

Given the large number of small buses available and the continual change of bus models, only summary information for each service-life category will be discussed. Tables 24–28 provide examples of buses for each service-life category. These examples are only a "snapshot" in time of the kinds of vehicles available to transit agencies. They are offered as descriptive information examples, and the listed vehicles do not in any manner constitute an endorsement or recommendation of the example vehicles. The data presented in Tables 24–28 are based on information received in the responses to the Small Bus Manufacturers Questionnaire, from manufacturers technical sales and product information literature (*17*), and from ABTC reports (*15*).

The 4-year service-life buses are either a van conversion or a BOLDC vehicle. They usually have a single door and multiple steps for boarding and alighting. The first step is generally 10 to 12 inches. The suspension systems do not provide for kneeling. For the BOLDC vehicles, passengers using wheelchairs are provided access by a wheelchair lift installed in a door separate from the ambulatory passenger door. The lift door is generally located behind the rear axle, but some are located adjacent to the passenger door. Most van conversions have a ramp access for passengers using wheelchairs. The ramp access is located either in the rear or side door of the van.

The 5-year service-life vehicles are all BOLDC vehicles and have features similar to the 4-year vehicles. The major differences are that the GVWR is generally higher, and the bus lengths can be longer. These differences enable the 5-year buses to have slightly higher capacities. The manufacturers

TABLE 27
EXAMPLES OF 10-YEAR SERVICE-LIFE SMALL BUSES

Characteristics	Bus 1	Bus 2	Bus 3
Lengths (feet)	27	29.8	31
No. of seats*	22	26–28	28
Entrance height (in.)	14	14.5	12.7
Entrance height kneeled (in.)	No kneeling	11.5	7.7
No. of steps to floor of bus	4	3	1
Type of suspension (spring or air)	Spring Air (optional)	Air	Air
No. of doors	1	1 or 2	1 or 2
Turning radius (feet)	30.4	30	32.5
GVWR (lb)	26,500	29,800	31,000

Sources: Small Bus Manufacturer's Questionnaire and Technical Sales and Product Information Literature (*17*).
*Maximum number of seats with floor plan meeting ADA requirements.

TABLE 28
EXAMPLES OF 12-YEAR SERVICE-LIFE SMALL BUSES

Characteristics	Bus 1	Bus 2	Bus 3
Lengths (feet)	30.7	30	26.3
No. of seats*	29	29	24
Entrance height (in.)	13.1	15	12
Entrance height kneeled (in.)	10	11.5	8
No. of steps to floor of bus	1	3	1
Type of suspension (spring or air)	Air	Air	Air
No. of doors	1 or 2	1 or 2	1 and 1 Rear
Turning radius (feet)	31	33	34
GVWR (lb)	31,280	37,600	24,000

Sources: Small Bus Manufacturer's Questionnaire and Technical Sales and Product Information Literature (*17*).
*Maximum number of seats with floor plan meeting ADA requirements.

of 4-, 5-, and 7-year small buses have models with lengths that range from 20 to 30 ft. Some offer longer vehicles using tag axles.

The 7-year service-life small buses have a wide range of GVWR. Some models are BOLDC and others are BOMDC. One recently introduced model uses integral design and construction technologies. Three models offer low-floor features. When the medium-duty chassis is used, the number of steps at the entrance may increase by one step. Also, because these buses tend to be longer, the manufacturers offer models with one or two doors. Wheelchair access is by lift for the body-on-chassis models and by ramp for the low-floor models. The wheelchair lift is generally located in a door behind the rear axle, but some have the option of locating the wheelchair lift in a doorway adjacent to the passenger door. One manufacturer offers a lift installed in the passenger doorway. The first step at entrance height is similar to the 4- and 5-year vehicles. Generally, a kneeling feature is not available, although one of the low-floor models offered kneeling.

The 10-year bus models begin a transition from medium-duty to heavy-duty vehicles. Many are manufactured using BOMDC. Some small bus manufacturers fabricate their own chassis, and others use a medium-duty truck chassis. One difference between these approaches can be in the number of steps required to enter the bus. The truck chassis may require four steps for entry, whereas the bus chassis generally requires only three steps. The kneeling feature is not offered on most BOMDC models, because most of these models have spring suspension systems. Some manufacturers offer an "air ride" option that has an air suspension on the rear axle and a spring suspension on the front axle to provide a softer ride. This option does not provide for a kneeling capability. The height of the first step for a 10-year bus is similar to that found for the 4-, 5-, and 7-year buses. There is one 10-year bus that is a low-floor model and also provides a kneeling capability. For the BOMDC models, wheelchair access is provided by lifts that are generally located in a door separate from the ambulatory passenger door. However, one BOMDC model offers a lift that is installed in the passenger door. Wheelchair access is provided by a ramp for the low-floor model. The 10-year small buses provide an increase in capacity over the 4-, 5-, and 7-year small buses and the potential for a smoother ride with the use of air suspension technologies.

Many of the 12-year service-life small buses in current service are essentially shorter versions of the 40-ft large bus produced by the manufacturer. As such, the buses use the integral body-on-*bus*-chassis design and manufacturing technologies that are used in the larger buses. They also have air suspension systems and a kneeling capability. The

numbers of steps at the doorways are three for the high-floor models. Currently, there are two models that are low-floor in design and construction, and these models are equipped with air suspension and have a kneeling capability. Wheelchair access is by a lift located in a passenger door for the high-floor models and by a ramp located in a passenger door for the low-floor models. As will be discussed later in this chapter, a number of 12-year small buses are being introduced to the transit market. These new entries use both integral and body-on-chassis design and construction technologies.

FUEL CONSUMPTION PERFORMANCE

One of the tests conducted at the ABTC is a fuel consumption test that is a procedure based on the Society of Automotive Engineers (SAE) Fuel Economy Measurement Test (Engineering Type) for Trucks and Buses: SAE 1376 July 82. The major change in the test procedure is the elimination of a control vehicle. The operating cycle used for the test is the Transit Coach Operating Duty Cycle (ABD Cycle).

The fuel consumption test data for small buses were extracted from the ABTC report for those vehicles that completed the test. The results of these tests are given in Table 29 and are grouped by service-life category. The table provides the overall average fuel consumption for the entire test operating cycle, and the high and low values for each small bus category. For comparison, Table 29 provides data about fuel consumption tests for six 40-ft low-floor models.

Using the large bus average fuel consumption as a baseline, the average fuel consumption for the small buses was compared to the average fuel consumption of large buses. The results of this comparison are given in Table 30.

For the small buses using liquid fuels, the fuel consumption was lower for all small bus categories. The differences ranged from 7 to 78 percent. The differences in fuel consumption were less dramatic for the gaseous fuel vehicles. In this case, the differences ranged from −15 to +27 percent.

Information on fuel consumption experiences was collected from several systems. Table 31 shows the operational fuel consumption experiences of the systems.

The operational differences in the use of a vehicle have a large impact on its fuel consumption. Connecticut Transit's experience is an excellent example. It used the same bus model in three locations with different uses. Hartford uses the bus in regular linehaul service during weekend and evening hours when the average system speed is highest. In this case, the average fuel consumption was 4.13 mpg. This service tends to be at low speed and with considerable idling time. Stamford average fuel consumption is 3.12 mpg. Stamford uses the bus in a shuttle service between downtown businesses and the railroad station. New Haven uses the bus as a shuttle service between the New Haven Coliseum and the Union Railroad Station. The distance is approximately 1 mile, with significant idling time. New Haven average fuel consumption is 3.04 mpg. The same bus model in three different operational uses had differences in fuel consumption of more than 35 percent.

EXTERNAL NOISE PERFORMANCE

Community complaints about noisy, large buses have been a reason that some systems use small buses. To investigate whether or not small buses were less noisy than large buses, data from the ABTC was reviewed. The ABTC conducts external noise tests under test conditions where

TABLE 29
SMALL BUS FUEL CONSUMPTION ALTOONA TEST DATA BY SERVICE-LIFE CATEGORY

Vehicle Category	Fuel Consumption Test Data					
	Liquid Fuel (mpg)			Gaseous Fuels (m/lb)[a]		
	Average	High	Low	Average	High	Low
4-year[b]	7.04	9.69	6.86	1.04	1.07	1.00
5-year[b]	7.75	9.16	5.49	0.95	0.95	0.95
7-year[b]	7.29	8.85	6.31	0.93	1.01	0.83
10-year[c]	6.33	7.20	5.42	0.94	0.94	0.94
12-year small bus[d]	4.66	5.19	4.10	0.70	0.78	0.62
12-year large bus[d]	4.36	4.97	3.80	0.82	0.88	0.75

Source: ABTC (*15*).
[a]Miles per pound.
[b]Diesel and gasoline fuels.
[c]Diesel fuels.
[d]Diesel liquid fuel and compressed natural gas and liquefied natural gas gaseous fuels.

TABLE 30
COMPARISON OF SMALL BUS AND LARGE BUS AVERAGE FUEL CONSUMPTION (ALTOONA TEST DATA)

Small Bus Category	Difference in Fuel Consumption Compared with Large Buses			
	Liquid Fuels		Gaseous Fuels	
	mpg	%	m/lb	%
4-year	2.68	61	0.22	27
5-year	3.39	78	0.13	16
7-year	2.93	67	0.11	13
10-year	1.97	45	0.12	15
12-year	0.3	7	–0.12	–15

Source: ABTC (*15*).

TABLE 31
FUEL CONSUMPTION EXPERIENCES OF SEVERAL TRANSIT SYSTEMS

Transit System	Service-Life Category	Average Fuel Consumption (mpg)	Altoona Same Category (mpg)
Kansas City Area Transportation Authority	4- and 5-year	8.75	7.04–7.75 (avg.) 5.49--9.69 (range low to high)
Port Authority of Allegheny Co.	7-year	5.25	7.29 (avg.) 6.31–8.85 (range low to high)
PACE	7-year	5.73	
Charlotte Department of Transportation	7-year	6.7	
PACE	10-year	5.88	6.33 (avg.) 5.42–7.20 (range low to high)
Kansas City Area Transportation Authority	10-year	4.7	
Charlotte Department of Transportation	10-year	7.2	
Kansas City Area Transportation Authority	12-year	4.52	4.66 (avg.) 4.1–5.19 (range low to high)
Connecticut Transit	12-year	3.04–4.13	

Sources: Questionnaire for Transit Agencies Using Small Buses, KCATA (*4*), Port Authority of Allegheny County (*8*), PACE (*18*), and First Transit (*19*).

the bus is both stationary and accelerating. These tests are based on SAE J 366 Exterior Sound Level for Heavy Trucks and Buses. Table 32 provides a summary of the noise test data. Averages for each service-life category were calculated. The table also shows the averages of the external noise data for six low-floor 40-ft buses for comparison purposes. The new industry bus procurement guidelines specify a maximum of 83 decibels [dB(A)] for exterior noise generated by the bus (*20*). The average measured noise levels for the small buses were lower for all small bus categories compared with the large bus average measured noise levels.

SMALL BUS CAPITAL AND MAINTENANCE COSTS

Small Bus Capital Costs

Information on the capital costs of small buses was gathered from the manufacturers and from the *APTA 2000 Transit Vehicle Data Book* (*2*). The *Data Book* contains a section where the costs of vehicles purchased in the reporting year are provided by some of the APTA transit system members. This issue of the *Data Book* includes 811 small bus purchase prices under the classification of motor bus, and 1,357 for the classification of demand response. These data were analyzed to determine the average cost and cost range for specific models by service-life category.

In the motor bus classification, the new small bus purchases were 64 percent high-floor and 36 percent low-floor, and 86 percent used either diesel or gasoline as fuel. Seventy-four percent were 10- and 12-year service-life buses. In the demand-response classification, the new small bus purchases were 96 percent high-floor and only 4 percent low-floor, and approximately 97 percent used diesel or gasoline fuel. A cautionary note is that the APTA data represent only a portion of the new small bus purchases on a national basis, and as such may not accurately reflect actual national purchase prices. Figure 19 presents purchase prices for small buses by service-life category for the APTA motor bus and demand-response purchases in 2000. There are fairly wide ranges in the purchase prices for the 7-, 10-, and 12-year categories. The highest price for the 7-year category resulted from a purchase of a turbine hybrid-electric small bus. Without that purchase, the highest price would have been about $50,000 lower.

Small Bus Maintenance Costs

Small bus maintenance cost data were obtained from four transit systems. These data are for periods of 12 to 18 months. For the Port Authority and PACE the maintenance was by a contractor and for Tri-Met and Charlotte the maintenance was conducted in-house. Table 33 provides maintenance costs for these systems.

TABLE 32
ALTOONA BUS TESTING CENTER EXTERNAL NOISE TEST DATA BY VEHICLE CATEGORY

Vehicle Categories	Average Exterior Noise dB(A)			
	Acceleration from Stationary		Stationary–Low Idle	
	Curb	Street	Curb	Street
4-year	72.6	72.8	57.7	59.1
5-year	73.5	72.9	56.5	57.0
7-year	75.2	75.9	58.8	59.1
10-year	76.5	77.0	62.9	63.5
12-year small bus	72.4	73.9	60.4	60.6
12-year large bus	77.1	78.0	64.4	63.9

Source: ABTC (*15*).

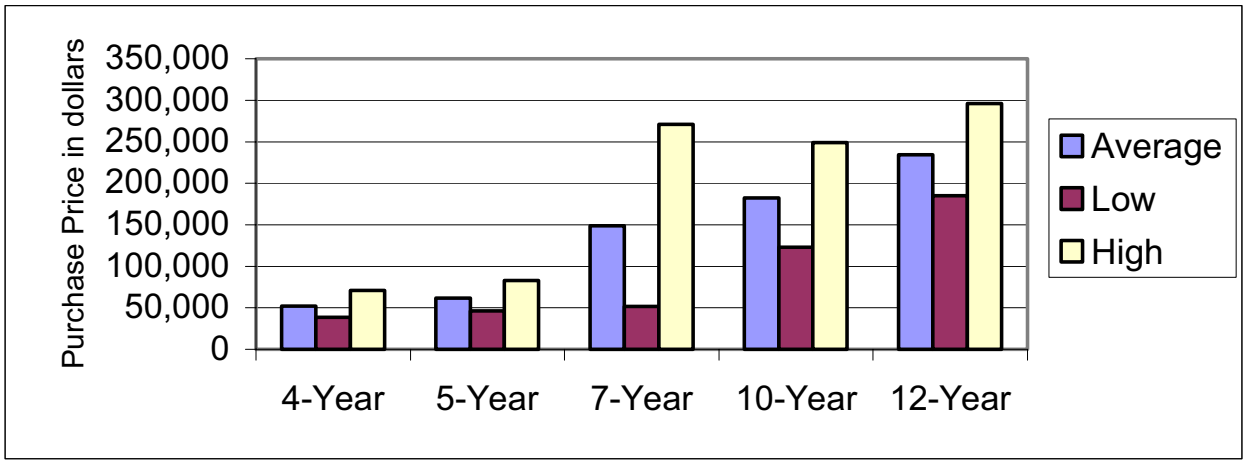

FIGURE 19 APTA purchase prices for small buses in 2000 (*2*).

TABLE 33
EXAMPLE MAINTENANCE COSTS FOR SMALL BUSES

Transit System	Service-Life Category	Maintenance Costs	
		$/vehicle-mile	$/vehicle-hour
Port Authority	7-year	0.38	4.67
Charlotte DOT	5-year	0.22	—
	10-year	0.18	—
	12-year	—	2.96
Tri-Met	12-year	—	2.54
	7-year	—	3.78
PACE	7-year	0.26	—
	10-year	0.12	—

Sources: Port Authority of Allegheny County (*8*), PACE (*18*), First Transit (*19*), and Tri-Met (*21*).

As can be seen in Table 33 there is no obvious relationship between service life and the maintenance costs of small buses. This is consistent with some of the User survey issues/concerns with the use of small buses, where some transit agencies expressed concern that the maintenance cost savings expected with small buses had not been realized.

RECENT EVOLUTION IN THE MARKET

In the past couple of years a number of new model small buses have been introduced to the transit market. Three manufacturers have developed models that are an adaptation of body-on-bus-chassis designs and technology that has been in use in Europe. These manufacturers are modifying the chassis and bodies to meet American regulation and market requirements (e.g., Buy America, ADA, Federal Motor Vehicle Safety Standards, and the location of the operator workstation). Some manufacturers are offering new models that are short versions of their 40-ft models. Other models are new bus designs using integral space-frame structure and fiberglass-reinforced composite body panels.

There appears to be a trend for bus manufacturers to use more stainless steel, aluminum, and composites in the design

TABLE 34
NEW SMALL BUS ENTRIES TO THE TRANSIT MARKET (as of 2000)

Technical Characteristics	Bus 1	Bus 2	Bus 3	Bus 4	Bus 5	Bus 6	Bus 7
Length (feet)	30.75	22	29	29.9	31.1	30.9	29.95
Maximum no. of seats	23	22*	28	27	27–1 door	33	23
Entrance height (in.)	14	12–13	15	13.5	11	13	15
Entrance height kneeled (in.)	11	8–9	11.5	10	8.5	10	9.5
No. of steps to floor of bus	1	1	1	1	1	1	1
No. of doors (1 or 2)	1	1	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2
Turning radius (outside corner) (feet)	33	31	29	25	31.5	24.9	33
Curb weight (lb)	18,500	15,000	21,000	20,000	15,500	16,500	16,000
GVWR (lb)	23,250	20,000	31,000	25,000	24,900	23,350	25,000
Types of fuel/energy: diesel, CNG, LNG, LPG, battery, H/E	Diesel	Battery LNG	Diesel	Diesel, CNG	Diesel	Diesel	Diesel
Altoona, status; completed, in testing, or in development	Completed	In testing	Completed	In testing	In development	In testing	In development

Sources: Small Bus Manufacturer's Questionnaire and Technical Sales and Product Information Literature (*17*).
*With one wheelchair position.
Notes: CNG = compressed natural gas; LNG = liquefied natural gas; LPG = liquefied petroleum gas; H/E = hybrid/electric.

and construction of small buses. As mentioned above, some are using a stainless steel structure with composite exterior panels, and other manufacturers are using combinations of steel chassis structure with aluminum and/or composite exterior panels. All of these approaches have the common objectives to reduce weight and improve the corrosion resistance of their vehicles.

All of the new entries are approximately 30 ft in length and low floor in design. All are being offered as 12-year service-life buses. The small bus manufacturers appear to be responding to a transit market that has indicated a desire for a more reliable and longer life small bus. In addition, these new models are equipped with air suspension that will improve the ride quality of the bus. The low-floor design provides easy access for all passengers with a single step entry for ambulatory passengers and ramp access for passengers using wheelchairs. Some of these new buses have completed the ABTC testing, some are undergoing testing, and others are in final production design and development.

Another new entry is a hybrid-electric small bus. The manufacturer has a small battery-powered bus in revenue service at several transit systems. This battery bus has been tested at Altoona as a 7-year service-life vehicle. The hybrid-electric model uses a turbine-powered generator. The hybrid electric propulsion system is a series hybrid electric. The main purpose of the addition of the turbine-powered generator is to extend the range of the vehicle to approximately 300 miles between battery recharging. The city of Tempe has ordered 31 of these buses, and delivery has begun. According to the *APTA 2000 Transit Vehicle Data Book* (*2*), the vehicle purchase price was about $271,000.

A concept small bus was shown at the 1999 APTA EXPO by a large bus manufacturer. It was a 30-ft hybrid-electric composite bus with a seating capacity of 26. The bus featured a one-piece composite body and chassis that was fabricated using a patented Seeman Composite Resin Infusion Molding Process. This is the same process that is used in the manufacturer's large composite bus. The model displayed had a small turbine using compressed natural gas (CNG) as a fuel. The curb weight with the CNG tanks was 18,700 lb. Although the market potential of this concept bus may be a few years in the future, it has clearly demonstrated the potential for using composites for small buses.

Table 34 provides information on the characteristics of all announced new entries at the time this report was written. The information in this table is from the manufacturers' documents, web pages, and surveys. These new entries significantly expand the choices available to transit authorities when procuring a small bus.

CHAPTER FIVE

EXPERIENCES WITH SMALL BUSES

USES OF SMALL BUSES

The importance of small buses in the transit industry is growing. The survey and case studies have illustrated a wide range of applications where small buses are being used by transit agencies, either as an alternative to large buses on linehaul fixed-route service or in more flexible service designs.

Small Buses as Alternatives to Large Buses on Linehaul Routes

Eighty percent of the User survey respondents were using small buses in scheduled fixed-route service. Many large agencies, as seen in the case studies of KCATA and SMART, had converted to smaller buses on routes that formerly used large buses, but where demand was low or had fallen. Although there are some cost savings from lower fuel consumption, the most important factor is the existence of a small bus wage rate. Conversion from large to small buses is much more cost-effective and likely to be pursued if a lower small bus wage rate has been negotiated. Information gathered during the case studies indicate that the availability of a small bus wage rate that is 70 to 80 percent of the large bus rate, combined with the savings in fuel consumption, allow for service at approximately the same subsidy per passenger on routes where demand is 30 to 40 percent lower than large bus capacity. In Kansas City, for example, the converted linehaul routes, using small buses, were carrying approximately 13 passengers per hour, 38 percent lower than the demand of 21 passengers per hour on the remaining large bus routes. The routes were still cost-effective because the costs of operating these routes was 27 percent lower per vehicle hour and 25 percent lower per vehicle mile.

A second situation was that of smaller transit agencies, especially in smaller urbanized areas, where small buses were more typical, and larger buses more of an exception. The User survey found that smaller transit agencies used small buses more extensively than other size agencies. Small buses represented on average 64 percent of the total active fleet for responding small transit agencies (i.e., those with fewer than 50 vehicles), versus 18 percent for all respondents to the User survey.

Non-Linehaul Flexible Service Designs

Beyond use on linehaul service, agencies used small buses in a wide range of more flexible services, including the following:

- 29 percent for neighborhood circulators and community bus service,
- 27 percent for demand responsive service open to the public,
- 26 percent for downtown circulators,
- 26 percent for route deviation service,
- 10 percent for flexible feeder service, and
- Other special applications including feeder shuttles to and from park and ride lots, commuter rail stations, airports, nature centers, etc.

The smaller size and maneuverability of small buses often make them more suitable for driving through parking lots, or for going through the circuitous and sometimes restricted access roadways for shopping malls, big box stores, industrial parks, hospitals, senior homes, etc. In one sense, small buses can provide a possible means of compensating for land use that is unfavorable to transit using large buses. Many suburban communities present a situation where land-use density, as measured by population or employment per square mile, is low, and pedestrian amenities (e.g., sidewalks, crosswalks, and barrier-free connections) may be inadequate or absent. Small buses can provide a means of overcoming the lack of pedestrian access by getting customers closer to their destinations in environments that are often unfriendly to pedestrians.

The case studies illustrated in more detail the great variety of ways in which transit agencies can use small buses to provide more flexible service designs. A number of factors can be used to design different types of flexible services using small buses, including

- Route deviation on request by customers, as in some of KCATA's MetroFlex service;
- Continuous loop design, frequently used to provide regular shuttle service to midday peak riders in downtown areas, suburban office campuses, or edge city concentrations;
- Circuitous fixed-route design that places more emphasis on reducing pedestrian access distance than on reducing travel time, as seen in the new services

developed by the Port Authority or in community bus-type service;
- Demand-response service in a given zone or community, oriented to serving intra-zone travel such as SMART's Dial-a-Ride or Community Transit;
- Designs alternating fixed-route and demand-response characteristics based on time of day, as in KCATA's MetroFlex; and
- Designs linking fixed schedule transfer locations or timepoints, with flexibly routed on-request pick-ups and drop-offs, as in SMART's Flexible Route and Pontiac Rainbow services.

Services involving customer requests also involve other dimensions of choice, including

- Same day or advance reservation service,
- Pick-up/drop-off at door or at predetermined stops,
- Customer request to central dispatch or to the operator directly, and
- Standard or premium fares to reflect extra cost of on-request service.

The survey and case studies show that, with perhaps the exception of some midday downtowner or peak hour commuter rail feeder shuttles, the flexible services involving the use of small buses are generally operating at periods of low demand, carrying typically less than six passengers per hour. Flexible services in low-density suburbs may be as low as three to four passengers per hour, which may be 80 percent lower than linehaul services. Pure demand-response service can be even lower than these levels.

It is clear that such services will result in a much higher than average subsidy per passenger. Negotiating a second tier lower wage rate may help to partially defray the cost as was done at KCATA, where a 55 percent rate could be applied for MetroFlex services. The remaining gap in subsidy per passenger can then be subject to negotiations with the community served, as with KCATA, or with private sector employers benefiting from the service, such as with the Port Authority's AIRCOR services. The total amount of the subsidy is likely to be small given the nature of these services and the small number of customers involved, but such services may assist in adding coverage to underserved parts of the service area.

ACCEPTANCE OF SMALL BUSES

Customer Acceptance

Customer acceptance was cited as an issue or concern by 39 percent of the User survey respondents, but this is lower than the 53 percent who cited vehicle reliability or the 42 percent that cited maintenance costs as issues or concerns. Based on follow-up discussions with some of the User respondents and on the case studies, a general pattern seems to emerge.

Customers certainly appreciate the more responsive types of transit services (e.g., demand-response or flexible-route services), where small buses greatly reduce walking distances and improve access. Typically, these routes are undertaken with the "smallest" of the small buses under consideration (i.e., van cut-a-ways), but operated under situations of quite low demand, where every customer gets a seat.

In addition, there appeared to be satisfactory levels of customer acceptance on the medium-demand linehaul routes, typically operated with the "largest" of the small buses under consideration (i.e., 30-ft versions of large bus models). These vehicles generally provide sufficient room to accommodate standees, are not claustrophobic, have acceptable air-conditioning and ventilation systems, and, above all, offer full air suspension, which provides a comfortable ride quality.

The problems of customer acceptance that were reported appeared to relate to specific design aspects of some of the BOLDC or BOMCD vehicles. The most common complaints reported were

- A hard and uncomfortable ride caused by the spring suspension, especially when compared to the level of comfort offered by air suspension on large buses;
- Noise, especially for vehicles with front and/or poorly soundproofed engines;
- Excessively hot in the summer, caused by engine location and poorly designed heating, ventilation, and air-conditioning systems;
- Difficult access for seniors with the steep four-step entry; and
- Uncomfortable location for wheelchairs in rear of vehicle, and perceived safety concerns when boarding using a rear-mounted lift.

Customer perceptions of these inherent vehicle design problems were greatly intensified in cases where the agency was using the buses on routes with severe overcrowding in the peak. The presence of standees created additional complaints about the single door used in most of these buses. It is difficult to enter or exit these small vehicles if standees are in the narrow aisles. Wheelchairs would create an even bigger problem.

There are, therefore, two different issues: (1) specific design problems found in some vehicles and (2) the use of any small bus in overcrowded conditions. More attention paid at the time of procurement may help address the first issue, but the second remains a dilemma. As expressed by one respondent, "while the small vehicles made sense from

a capacity-demand standpoint, it made no sense to have a separate fleet of vehicles to be used in mostly off-peak times." As a result, the small buses that may be well suited to off-peak levels of demand are pressed into service where they are insufficient, causing problems in customer acceptance and creating a negative image of second-rate service.

One final comment concerns the lack of market research. The previous assessment of customer acceptance is primarily based on anecdotal evidence and opinions provided by transit agency staff, based on their personal experience. There was a notable lack of formal market research (e.g., surveys or focus groups) to identify what kinds of customers were actually riding the small buses, to measure customer acceptance, or even to identify specific concerns. These factors are all the more significant because many of the services involving small buses were new to customers and sometimes experimental in nature.

Operator and Mechanic Acceptance

Overall operator acceptance was slightly less of a concern than customer acceptance, because it was reported by only 33 percent of the User survey respondents. However, the issues discussed above, which can affect customer acceptance, can also affect operator and mechanic acceptance. The operator will suffer the same kind of problems as customers given the small size of these vehicles. Some problems (such as noise and heat) may be even compounded in front engine buses, because the operator is literally sitting on top of the engine.

Although many respondents reported no specific issue related to acceptance by mechanics, a few did, but typically they related to the previous issues. In cases where customer and operator acceptance had deteriorated, mechanics ended up spending inordinate amounts of time trying to resolve problems that were in some cases inherent design problems associated with the BOLDC or BOMDC design or the poor design of the heating, ventilation, and air-conditioning system.

A few other maintenance issues were mentioned by User survey respondents, including drive train reliability, stress cracks in structural components, and poorly designed alternative fuel systems. The first two may also relate as much to the use made of the buses as to their inherent design, because consistent overcrowding of these buses would create considerable stress on any design weakness.

Community Acceptance

Enhancing the image of the agency in the community and addressing complaints from the community and residents were both ranked the third most important reason for purchasing small buses by respondents to the User survey. Follow-up conversations with respondents and case studies indicated that community acceptance of small buses is high, especially because they perceive small buses as offering a valid response that addresses community and political concerns about "the empty bus syndrome." In Kansas City, for example, local community leaders had been requesting the implementation of small buses for years, before a change in management and lengthy negotiations with the union finally fulfilled the community request.

Small buses can also provide a powerful symbol of significant change in management strategy. In SMART's case, the strategy of implementing small buses was critical in obtaining political and public support for the 1995 millage levy. It illustrated a significant change in management's approach to the design of services, away from the discredited large buses to a vehicle that was more appropriately sized for the reality of land-use patterns and demand for transit in the suburbs surrounding Detroit. Finally, it provided a tool for engaging in an ongoing dialogue with local municipalities and the private sector (e.g., mall owners and major employment centers). In LAKETRAN's case, the concept of deploying small buses in a flexible way, to serve the social needs of seniors and the disabled, was critical to LAKETRAN's success.

Finally, the combination of small buses and a lower small bus wage rate may create a very cost-effective solution for areas of low demand. This, in turn, can facilitate a new or renewed dialogue about cost-sharing of innovative service alternatives with underserved low-density communities in the region (e.g., Independence, Missouri, or Pontiac, Michigan) or even with the private sector (e.g., AIRCOR routes in Pittsburgh).

SAFETY EXPERIENCE

The User survey responses indicate that safety has not been a major issue/concern with the use of small buses. Only 8 of the 64 responses (12 percent) cited safety as an issue/concern, and only one survey respondent ranked safety as the most important issue/concern associated with the use of small buses. All of the respondents who had cited safety as an issue/concern reported that their overall experiences with the use of small buses were either acceptable or very good. Generally, they offered no explanations as to why safety had been checked as an issue/concern. Those that did provide some explanation of their safety concern made comments such as: safety had become an issue as buses age, there are standee safety concerns, and safety is a concern on only one particular type of vehicle.

One 30-ft rear-engine small bus was reported as developing an uncomfortable ride, described as "porpoise like," at speeds of about 50 mph or higher. In some systems, operators expressed their concerns about the safety of operating this vehicle at the higher speeds. The transit system solution was to use the vehicle on routes that do not involve high speeds.

The vehicle has a shorter wheelbase than other rear-engine buses of the same length. With the engine located in the rear, the rear overhang tends to be relatively long. The combination of these two dimensional characteristics (relatively short wheelbase and long overhang) would place a greater percentage of the vehicle weight on the rear axle, which may have resulted in the undesirable ride characteristic.

CHAPTER SIX

ISSUES

This study has identified a number of issues, which are expressed in the form of questions and dilemmas that face transit agency management in assessing and implementing small bus transit services. These are discussed in the following sections.

OVERALL STRATEGY

What Is the Agency's Overall Perspective with Respect to the Use of Small Buses?

Some transit agencies use small buses as a narrowly defined tool for specific applications where the use of the preferred large buses is physically constrained. Examples may include weight limitations on a bridge, size dimension limitations on secondary streets, shopping mall access roads, or vehicle performance in steep residential areas. In this case, the agency may be able to devote little attention to the planning and operational management of the use of small buses. At the other extreme, small buses are used by a limited number of transit agencies as an integral tool in the overall corporate strategy of providing service to customers. All four case study sites illustrated this approach. Based on this and other research (*22–24*), a growing number of regions are developing long-term plans similar to those being contemplated in the Kansas City region, in order to address the suburban transportation challenge. These plans generally propose linking transit centers, fed by feeder circulators or shuttles, with higher quality or timed-transfer connectors or express services. In such approaches, small buses play a major role in the feeder services to suburban transit centers and even, possibly, for lower demand connectors between transit centers. Irrespective of the specific strategy, the more small buses play a significant role in the overall strategy, the more attention is needed to carefully articulate their role within and outside the agency, and to devote the managerial attention and resources required.

What Are the Specific Market Segments That Are Being Targeted with the Use of Small Buses?

The range of applications where small buses might be used is considerable and they can serve extremely different markets. Examples identified in the case studies include

- Seniors making local trips from senior residences to shopping or health facilities primarily during off-peak hours,
- Peak-hour commuters traveling from residential neighborhoods to transfer points for linehaul bus routes or commuter rail lines,
- Peak-hour commuters transferring from trunk lines to access suburban employment center destinations,
- Midday office workers downtown or at edge city centers traveling from their offices to shopping centers and/or eating facilities,
- Off-peak shoppers accessing shopping malls or big box retail stores, etc.

Transit systems need to define more clearly their target client groups, understand their expectations, and define how the services, including those using small buses, should be designed to meet these expectations. The research revealed that transit agencies collect relatively little data on market research or even service performance, which makes any strategic approach to planning and management difficult.

How Is Cost-Effectiveness To Be Defined and Measured?

A more specific issue related to the above concerns the definition and monitoring of cost-effectiveness. It is clear from the research that the cost per hour of small bus service is lower than service using large buses, as a result of reduced fuel consumption and lower labor costs where a special small bus wage rate has been negotiated. However, the cost or subsidy per trip or per passenger mile varies tremendously depending on the nature of the service and demand. As a result, transit agencies need to focus particular attention on defining what constitutes cost-effective service in their context, define the metrics to monitor this, and collect the necessary data. The research found that with only a few exceptions, managers and staff responsible for planning or managing small bus services lacked access to basic cost-effectiveness data, either because of organizational divisions that restricted its availability or because it was lacking altogether.

LABOR ISSUES

Does the Leadership of the Agency Have the Willingness to Pursue the Negotiation of a Small Bus Wage Rate and Can It Sustain This Long-Term Effort?

The availability of a lower small bus wage rate is an important determinant in how cost-effective the service can

be and how significant will be the role of small buses in the overall corporate strategy. With the existence of a lower wage rate, small buses can be deployed in areas and at times of much lower passenger demand and still be within the parameters of acceptable cost-recovery ratios or subsidy per passenger for the agency or community. This asset enables much wider service coverage, improved access to transit services, and compensation for land use that is unfavorable to transit, in particular, to large buses. Without such a cost differential, it will be difficult to justify service in areas where demand is 50 to 80 percent lower. However, it is understandably a difficult issue to negotiate, and one that may need to be addressed incrementally, labor contract by labor contract. The typical pattern appears to be to negotiate separately unrestricted rights to apply a lower wage rate for *new* services and an often more restricted use of a lower wage rate for conversion of existing routes, or protection of existing employees. This also clearly takes a long-term approach, as was the case with KCATA or the Port Authority. The benefits can be considerable, but can the effort be sustained over time, given typical rates of management turnover? One agency that benefited from a lower small bus wage rate for a number of years has recently abandoned it, as a result of a change in management and in the agency's priorities in developing a new rail system.

How Should "Small Bus" Be Defined in the Negotiated Labor Contract?

As discussed in chapter 2, the research identified a number of approaches: by length of vehicle, by number of seats, by type of service for the route or run, etc. It is not clear from the research which is the most effective definition, because each definition appears to have advantages or disadvantages. It is critical that transit management consider this issue when developing a strategy, based on corporate objectives and available vehicle technology, but prior to negotiating the definition. This factor in most cases became a major constraint later on in the design of services or the choice of vehicles.

What Is the Relative Importance of Small Versus Articulated Buses for the Agency's Long-Term Corporate Strategy?

One issue concerns the trade-offs between articulated and small buses in the overall corporate strategy. In a few cases, transit agency managers reported that they had not pursued the negotiation of a small bus wage rate because they had been implementing or planning for articulated buses. They did not want to open up discussions on the possibility of a quid pro quo in the labor contract bargaining process, whereby the negotiation of a "lower" small bus wage rate would result in the negotiated outcome of a "higher" wage rate for articulated buses. This question relates back to the overall corporate strategy discussed previously in this chapter, and to whether small buses or articulated buses are more critical to the long-term strategy, and how it affects the agency's longer-term bargaining objectives.

What Is the Relative Balance Between Pegging the Wage Rate to the "Burden" of the Job Versus Seniority Considerations?

As seen in both the follow-up survey on wage rates and in the case studies a lower small bus wage rate does create a dilemma with respect to seniority. The lower wage rate is consistent with the fact that the job of operating small buses is less onerous than that of operating large buses. However, in a labor environment strongly based on seniority considerations, as is transit, senior operators may consider that they have earned the right to choose the individual work that best meets their individual expectations about the combination of salary and work conditions. Many agencies separate these two pools of operators, with separate picks, to ensure that entry-level operators must work on the lower-paid small bus runs. The irony is that these lower-paid employees generally enjoy the better work conditions attractive to senior operators, even at lower pay. This became one of the major issues in the strike that affected Calgary Transit in early 2001. An alternative is the approach adopted by the Port Authority, where there is a nominal relationship between the number of runs using small buses and the number of operators paid the lower wage rate. It is, however, complicated and reduces the transparency of the system, especially to junior operators. No preferred approach to this issue is clear at this time, and it should be an area for future research.

VEHICLE SELECTION AND RELIABILITY

How Does One Define the Vehicle Features Required for the Service and Select the Appropriate Small Bus?

The two highest ranked reasons (each being cited by 74 percent of the User survey respondents) for purchasing small buses were "maneuverability of a small bus" and "matching capacity to demand." Clearly, one needs to select vehicles that meet the transit agency's needs with respect to these two features. Of the two, the maneuverability requirements can probably be met by most of the small bus models available. Capacity is a more defining requirement. Although there is considerable overlap of vehicle capacity versus service-life category (also vehicle GVWR), generally, the seating capacity requirements define the vehicle length and, most likely, the service-life category.

In addition, ride quality was frequently cited as a source of customer and operator complaints. If ride quality is a major concern, such as with long trip times, then consideration of small buses that have air suspension could be important. If the customers using the small buses are mostly seniors, adults with small children and/or packages, or customers using wheelchairs, then small buses with easy access (e.g., low-floor) would also be an important factor. From the survey responses and site visits it is also clear that buy-in by both the operator and maintenance personnel is needed in the acquisition of small buses. The analysis of the survey responses and discussions during site visits emphasized the importance of small bus acceptance by these staff members to achieve a good experience with small buses. A final, and many times constraining, feature is vehicle cost. Clearly, the longer life and more heavy-duty small buses will cost more, some approaching the cost of a large bus. However, there are rewards in improved reliability and a more comfortable ride. With the many and some times interrelated features to be considered, management needs to give the selection of a small bus the same importance it gives the selection of a large bus.

What Will Affect Vehicle Reliability and Performance?

The most important issue/concern with the use of small buses by the User survey respondents was reliability. This concern was mostly directed at the 4- and 5-year (lower GVWR) vehicles. However, some comments concerned heavy-duty small buses as well. These concerns mostly related to problems such as wheelchair lifts, air conditioning, and accessibility. For the small buses in service for several years, "problem" buses become known in the transit community, and the system could benefit from surveys of the experiences at other systems before their final selection.

For new vehicle models, the ABTC reports on a small bus under consideration are an inexpensive ($12 per report) way to obtain objective information on some aspects of the vehicle. The most important test is the durability test, and how the vehicle performs during this test can be very revealing. Also, the fuel consumption test results will give some insight on the potential for saving in fuel costs. The noise tests provide information on both the external and interior noise of the small bus under consideration. Finally, if a demonstrator is available for a small bus under consideration, placing the "demo" vehicle in test service could uncover problems with handling and/or road clearances, and also would provide an opportunity for operator and maintenance staffs to assess the pros and cons of the vehicle. The demonstrator could also be used to probe the reactions and concerns of potential customers that would be served by the small bus, through on-board surveys or focus groups.

IMPACT OF LOWER VEHICLE CAPACITY ON TRANSIT OPERATIONS

How Significant Is the Often-Expressed Concern That Small Buses, with Their Lower Capacity, Significantly Constrain Transit Operations?

Given the general lack of information available, this issue became principally a matter of personal opinion. A few agencies with small buses had decided to reduce the number of small bus routes or had decided to phase out certain size categories of buses because of capacity constraints, but it was difficult to determine, given the lack of data, the real underlying cause of these decisions. In some cases, it appeared to be the result of ridership success, where demand had grown to the point that the routes fell within the parameters of large buses. In others, it appeared that the problems were more a result of organizational considerations, in terms of internal resistance by operations staff, a lack of concern or attention by senior management for a relatively niche service, a lack of training, or poor service monitoring and planning. From a managerial point of view, it is clearly easier to address this problem by reverting back to the purchase of large buses, rather than to tackle some of these thorny issues. This consideration is all the more the case given the ability to fund vehicle purchases with only a 10 or 20 percent local match. This clearly undervalues the cost of capital, which is, for example, in stark contrast to the United Kingdom, where small buses are much more prevalent. It should also be noted that far more transit agencies are expanding their use of small buses than are reducing or abandoning them.

Can Small Buses Be Used in the Peak?

The use of small buses during peak periods is a common concern. Transit managers sometimes cannot justify investing in small buses because their lower capacity would force them to be underutilized or totally idle during peak periods when transit needs to use all of its resources. Some transit managers believed that this issue was made even more difficult if an agency's service was highly peaked or if there was a significant amount of interlining in the scheduling process. The higher the peak-to-base ratio, the more the agency is oriented to serving commuter travel, and this choice usually translates into crush loads at the peak and the use of dedicated express services on unidirectional peak flows. In some cases, agencies with high peak-to-base ratios find advantageous the extensive use of interlining in their scheduling process to match cost-effectively disparate pieces of unidirectional services across the entire region, and thus minimize costly deadheading. Small buses can clearly not be used in crush load situations, because this appears to be a problem with some of the poor experi-

ences to date with customer acceptance, as previously discussed. In addition, having a wide variety of different capacity vehicles will clearly add constraints and complexity to the interlining analysis.

Other managers believe that capacity-related problems are overstated. A proper definition of the hierarchy of services, the markets they serve, and the parameters of acceptable performance, is clearly needed. In addition, all of this needs to be combined with a careful route performance monitoring system that will ensure that service on a given route is provided with the appropriate choice of service and vehicle, and that modifications can be implemented in a timely manner as conditions of demand change. In this view, such tools and strategies should be in place in any case, irrespective of whether small buses are used or not. Agencies can also address problems on specific routes by redesigning the service with multiple routes serving common trunks or with peak-hour supplemental feeder services. The more extensive the use of small buses in different types of services the more flexibility may be offered to the agency to address capacity concerns. For example, an agency might consider a region-wide matching of small bus services designed specifically for off-peak markets (e.g., Dial-a-Ride for seniors) with other small bus services designed for peak markets (e.g., commuter rail or suburban employment feeder shuttles). An open question also concerns the true cost of leaving a small bus fleet idle during the peak, if small bus operators are only paid for their platform hours, as is the case in some agencies, and capital is relatively undervalued. These issues are important for transit managers to consider, given the perceived importance of the "capacity" issue.

MANAGING A MIXED FLEET

How Can the Maintenance Requirement of Small Buses Be Properly Addressed in Transit Agencies Where Standard Operating Procedures Have Relied for Years on the Standardization of Equipment?

The operation and maintenance of small buses may sometimes create unique requirements in terms of parts stored, fuel used, maintenance procedures, training of operators and mechanics, etc. The greater challenge is not related to the small buses themselves, but rather to the integration of a nonstandard vehicle into the agency's standard operating procedures, and to changing employee and midmanagement existing mindsets—perceptions and attitudes. The first challenge requires difficult organizational change. The introduction of any new vehicle in the fleet requires management attention to setting up new procedures and responsibilities and providing necessary training. Small buses are no different, although the problem may be underestimated because of their smaller size. Poorly planned procedures will result in a growing stream of problems that may eventually lead to their abandonment. The second issue concerning staff mindsets is perhaps more unique to small buses. There will always be a tendency for employees and management to view the smaller vehicles as a junior and less prestigious sibling. Management must clearly articulate the role of small buses in the overall corporate strategy and its place in winning over new riders.

Who Is Responsible for Deploying the Vehicles and Ensuring Service Quality?

A corollary of the previous question concerns responsibility for the service. Specifically, designating responsibility for the introduction of the vehicles into operations is essential as is managing their operations until they become mature. This is particularly true if the new vehicles are also being used in new service design applications. New procedures for both the vehicles and the service will need to be developed. Service quality needs definition and monitoring, the inevitable problems will need addressing, and complaints must be handled. These steps will be further complicated if new variables are involved, such as when leasing vehicle maintenance or if the new service creates labor stress. The Port Authority experienced both situations. It is important to clearly define responsibilities at the outset.

OTHER OPERATIONAL ISSUES

Should Request-Based Flexible Services Be Centrally Dispatched or Should Customers Contact Operators Directly to Schedule Pick-Ups and Drop-Offs?

This issue surfaced in a number of cases, with some agencies adopting the central approach to the dispatching function, and others adopting the decentralized approach. The first creates a standard approach and level of service, but introduces another layer between the customer and the service that can cause problems. The second brings the service closer to the customer, provides more flexibility, gives more responsibility to the operator, and possibly reduces dispatching costs, but could raise concern over quality standards.

Can Computer Technology Assist with the Complex and Labor-Intensive Task of Dispatching Innovative Paratransit Service?

Since the early demonstrations of the first demand responsive services in Haddonfield, New Jersey, and Rochester, New York, there has been considerable discussion of the potential use of technology to enhance the effectiveness

and efficiency of small buses deployed in innovative para-transit services and to assist in handling requests, scheduling services, and dispatching service. The ultimate hope is that technology will one day make feasible real-time dynamic scheduling of demand-response service. This approach would most likely combine a variety of technologies, including

- Interactive voice response technologies for handling customer requests,
- Accurate automatic vehicle location of buses,
- Powerful mathematical algorithms for calculating shortest path assignments,
- Fast processors to make the calculations feasible, and
- Reliable communications systems with on-board mobile data terminals.

Much progress has been made in some of these areas, but this study did not identify any specific implementation where this technological approach has been successful. Computer-assisted real-time scheduling and dispatching of demand-response service cannot, therefore, be considered a mature technology. However, it is certain to evolve in the coming years, and transit managers should monitor its development.

"BRANDING" OF SMALL BUS SERVICES

How Should New Services Involving the Use of Small Buses Be "Branded"?

The positive marketing image provided by small buses was the third highest rationale cited by User survey respondents for purchasing and implementing small buses. This was further reinforced by the case studies, where the positive image provided by small buses was used to enhance public and political support, and to help persuade voters to pass tax levies to support transit. Image is therefore an important consideration. It is also important at the consumer level, to help them better understand the nature of the small bus service, especially in contrast to other transit services, and thereby to facilitate their use of the small bus service. It was, therefore, surprising to see how little attention image received. In some cases, the vehicles benefited from a modified paint scheme, and in a few instances, a highly distinguishable color or full-body paint scheme. However, a review of system maps, schedules, and websites showed that only a minority created a significantly different identity for the small bus services, even when they were extremely different in their service design from linehaul service operating large buses. Some examples of how the case studies supported the image of small bus services include

- The use of different sized bus pictograms on KCATA's schedules;
- The use of the specific logos associated with the service, such as on the Port Authority's AIRCOR or GoldLink services; or
- The use of route color-coding on SMART's Pontiac Rainbow Service.

However, these represent minor efforts in light of the number and range of small bus applications identified by the research. More market research is needed to test customer understanding of innovative service concepts, and to assess customer reaction to "branding" schemes. There remain many related questions about the trade-offs between the benefits of branding and the need for flexibility when services are being implemented on an experimental basis. These questions will be all the more important if transit agencies move into comprehensive mobility strategies for suburban public transportation, such as the one being contemplated in the Kansas City region.

CHAPTER SEVEN

CONCLUSIONS

This synthesis of research explored the use of small buses in the transit industry. Small buses were defined, for the purposes of this study, as vehicles used in public transit service, open to the general public, that were 30 ft or less in length. Americans with Disabilities Act-type service, available only to eligible customers, was excluded. The study involved several tasks, including a survey of transit agencies in North America using small buses, a survey of transit agencies that do not use small buses, a survey of bus manufacturers, reviews of documents and websites, follow-up communications with transit managers and staff, and four detailed on-site case studies. Conclusions drawn from the research are briefly outlined here:

- Approximately 58 percent of the transit agencies that are members of the American Public Transportation Association or the Canadian Urban Transit Association and operate surface transit have small buses in their fleets.
- Assuming the survey response is representative of transit in urbanized areas, small buses represent on average 18 percent of the fleet of those agencies that operate small buses.
- The significance of small buses varies directly with the size of the agency. Small buses represent on average only 10 percent of the fleet for the largest transit agencies, those with more than 500 buses, but an average of 64 percent for the smallest transit agencies, those with a fleet of fewer than 50 buses.
- There are a huge variety of small buses in operation, with respondents to the survey operating 57 different models. Forty percent of the small buses operated by the User survey respondents were in the 10- and 12-year service categories, and this was the same percentage as the number of small buses in the 4- and 5-year categories. The remaining 20 percent were in the intermediate 7-year category.
- Based on the survey responses, the two important rationales for purchasing small buses are the ability to match capacity with demand and their maneuverability on small streets. Other important rationales were the positive marketing image of small buses and their use in addressing community complaints.
- Eighty percent of User survey respondents use small buses in fixed-route service.
- Small buses are also used in a variety of more flexible service design applications, including circulators, demand-response service, route deviation, and various forms of flexible feeder services.
- Overall experience with small buses has been "very good" for 44 percent of the User survey respondents, and "poor" for only 15 percent of respondents. However, the level of reported satisfaction varies directly with the number of small buses in the fleet, and indirectly with the size of the total fleet.The lowest levels of satisfaction were found in large transit agencies operating a relatively smaller proportion of their fleet as small buses.
- Some agencies have had extremely poor experiences with small buses, which has often been associated with the poor reliability of specific vehicle models. These problems are further compounded when the small buses are operated in peak-hour service with overloading conditions. This situation can also create significant problems with customer and operator acceptance.
- The continual change in bus model features, and even in names for similar models, are a major source of confusion for transit agencies, making it difficult for transit managers to easily distinguish, through conversations with colleagues, the actual experience with respect to different bus models. This, in turn, appears to lead to a general broad-brush negative image for small buses in general.
- The most common areas of concern are shared by both users and non-users of small buses. These are, by order of importance, the reliability of the vehicles, the maintenance costs of small buses, and the capacity of the vehicle and the perceived constraints that smaller capacity may impose on its deployment.
- The negotiating of a lower small bus wage rate significantly decreases the cost of operating small buses, measurably increases their cost-effectiveness, and compensates for the lower levels of demand in suburban areas where they are often deployed.
- Negotiating a lower small bus wage rate can be a lengthy process that may need to be pursued over several successive contract negotiations.
- Small buses also benefit from savings in fuel consumption.
- The case studies have illustrated how small buses can be used in a wide range of service design concepts aimed at very different market segments. They have shown how small bus-based services can be an important and integral component in a Family of Services overall strategy. In particular, they can provide a flexible and cost-effective tool in serving low-density suburbs, where auto-oriented land use and the

lack of pedestrian amenities make them difficult to serve with traditional linehaul transit using large buses.

Chapter 6 discussed 16 different issues, articulated as questions and dilemmas, which face transit management when assessing and implementing small bus transit services. The following section identifies a number of conclusions based on the discussion of these issues.

- The most successful implementations of small buses build on a more strategic approach to the planning of transit services. A comprehensive strategy should articulate the role of small buses and the markets they are to serve. Senior management needs to carry this strategy through the implementation stage, with a clear identification of responsibilities, careful attention to vehicle selection, and the appropriate development of procedures and monitoring systems.
- Data collection and monitoring are critical. It requires the design of appropriate metrics and the development of an ongoing system for collecting data on route performance, maintenance costs, overall cost-effectiveness, and customer complaints. Periodic market research on customer acceptance and concerns is also critical, especially in the early stages of implementation of innovative or experimental services.
- Small buses offer great potential toward building a positive image for the transit agency, but must be recognized as different from the customer's perspective. More attention needs to be devoted to the provision of customer information in general and to the creative and consistent "branding" of these services at all levels (printed schedules and maps, route nomenclature, vehicle paint schemes, stop design and information, website information, etc.). These enhancements could help ensure that customers understand how to use these nonfamiliar services, and will also maximize the potential benefit from promotion and image building.
- Given the range of vehicle choices, and the various issues related to vehicle reliability and comfort, preselection research and, if possible, testing of demonstrator vehicles, is highly recommended. This will assist in determining customer, operator, and mechanic acceptance and ensuring satisfactory vehicle reliability under the vehicle's actual operating conditions. In addition, a review of the pertinent Altoona Bus Testing Center (ABTC) reports should be systematically conducted. The ABTC reports are a vital source of information for maintenance managers. They could be more widely disseminated and their use encouraged.
- Deployment of the vehicles should be realistic in terms of actual passenger capacity. Small buses can play an important role, but cannot be expected to perform adequately if they are used in situations where demand exceeds capacity. This should be recognized in the scheduling process, and the previously mentioned route monitoring systems should help to identify problems as soon as they occur.
- Small buses can be used in a wide range of applications. Creativity can build on their inherent flexibility in deployment. However, deployment of innovative services should relate to a coherent strategy, and not be ad hoc in nature. Otherwise, it may just increase customer and staff confusion.
- Introduction of small buses can be disruptive to the agency's well-established operational routines and procedures that are based on large buses. Senior management needs to clearly and continuously communicate the significance of small buses in the agency's corporate strategy in order to overcome the inherent organizational inertia and/or resistance.
- In the case of demand-response or on-request flexible services, management needs to pay particular attention to the implementation of procedures involving customers, to the development of an ongoing system for ensuring quality and for monitoring complaints, and to the training of operators and dispatchers.
- Transit management should monitor future developments in technology, in terms of both small bus technology and computer-assisted scheduling and dispatch systems for demand-response service. The former relates to considerable changes affecting the supply market for small buses, which may offer more choice to transit agencies. In terms of the latter, this technology, as it matures, may offer the potential to enhance the productivity of demand-response services.

Three areas for future research have been identified.

- Research would be useful to better understand *the cost-effectiveness of innovative small bus services* under different circumstances. Such research should collect cost-related and ridership data for different types of small bus services, operated under different circumstances, in terms of land-use and cost regimes (e.g., with or without a lower small bus wage rate). These data could then be used to explore the impact of different cost frameworks and the influence of different land-use patterns on levels of demand for different types of services, in order to develop a better understanding of how these different factors affect the cost-effectiveness of innovative small bus applications, in particular in areas of low demand.
- More research could address the complex *labor-relation issues surrounding the negotiation of a small bus wage rate*, as discussed in chapter 6. This research might explore the different strategies pursued in negotiating a small bus wage rate and analyze differences in the approaches to implementation, in terms of the definition of small bus, seniority, pro-

gression, part-time labor, etc. The research should recommend local and even national strategies for negotiating an acceptable small bus wage rate that would promote wider deployment of small buses.

- Finally, although not specific to the issue of small buses, the study affirmed the need for more research on the issue of *vehicle performance measurement*. Such research should first explore how transit systems can use the ABTC data to better understand the characteristics and performance of different bus vehicle models before purchase. The transit industry needs to be made more aware of this source of information and how it can be used. The research of transit systems should also track the performance of the vehicles in their fleets, and the potential use of vehicle performance measurement data to improve the cost-effectiveness of their maintenance programs.

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ACRONYNMS AND ABBREVIATIONS

Transit Agencies

KCATA	Kansas City Area Transportation Authority
LAKETRAN	Lake County Regional Transportation Authority
PACE	Pace Suburban Bus Division of RTA
SEMTA	Southeastern Michigan Transportation Authority
SMART	Suburban Mobility Authority for Regional Transportation
Tri-Met	Tri-County Metropolitan Transportation District of Oregon

Government

ABTC	Altoona Bus Testing Center
ADA	Americans with Disabilities Act
FTA	Federal Transit Administration

Transportation Organizations

APTA	American Public Transportation Association
CUTA	Canadian Urban Transit Association
SAE	Society of Automotive Engineers

Other

ACTA	Air Corridor Transportation Association
CMAQ	Congestion, mitigation, and air quality
BOLDC	Body-on-light-duty chassis
BOMDC	Body-on-medium-duty chassis
CNG	Compressed natural gas
FMVSS	Federal Motor Vehicle Safety Standards
GVWR	Gross vehicle weight rating
HVAC	Heating, ventilation, and air conditioning
LNG	Liquid natural gas
LPG	Liquid petroleum gas
STV	Small transit vehicle

APPENDIX A

Surveys to Transit Agencies and Bus Manufacturers

USE OF SMALL BUSES IN TRANSIT SERVICE

TCRP SYNTHESIS TOPIC SB-6

QUESTIONNAIRE FOR TRANSIT AGENCIES USING SMALL BUSES

*Purpose: The purpose of this survey is to gather information on **the use of small buses in transit service**, as part of a Synthesis of Practice being prepared for the Transportation Research Board. All public transit services, open to the public, using small buses are of interest, such as fixed route, route deviation, demand responsive, etc. [Paratransit services exclusively available for eligible customers (i.e., ADA or Specialized Transit) are not included in the scope of this study.] For the purposes of this study, small buses are defined as vehicles used in public transit service that are thirty (30) foot or less in length.*

Transit Agency _____ Date _____

Address _____
(Street)

_____
(City) (State/Province) (Zip/Postal Code)

Contact Name _____ Title _____
Telephone _____ E-Mail _____
FAX _____

Description of Service Area and Transit System:

Size _____ Population _____
Type of Community Served *(Please check all that apply)*

[ ] Urban [ ] Suburban [ ] College/University [ ] Small Urban [ ] Rural
Which of the above types of community is predominant? _____

Description of Active Fleet: Total Number of Buses _____ Number of Small Buses _____

Types of Services Using Small Buses: ***(Please check all that apply)***	**Name of Service (if any)**	**No. of Small Buses**
[ ] Scheduled Fixed Route		
[ ] Downtown Circulator		
[ ] Neighborhood Circulator/Community Bus		
[ ] Route Deviation		
[ ] Flexible Feeder Services		
[ ] Demand Responsive Zone Service		
[ ] Other		

What were the primary reasons for implementing small buses for the above services?
(Please rank, with 1 = Most important reason. Please add any comments.)

[ ] Complaints from community/residents (with respect to noise, vibration, etc.) _____
[ ] Funding allowing experimentation (e.g., CMAQ, etc.) _____
[ ] Lower capital cost _____
[ ] Lower operating/maintenance cost _____
[ ] Maneuverability on small streets _____
[ ] Marketing image _____
[ ] Matching capacity to demand _____
[ ] Other *(Please explain)* _____

Do you have **different wage rates** for operating **small** buses? [ ] Yes [ ] No

Has your overall experience with the use of small buses been: [ ] Very Good [ ] Acceptable [ ] Poor

Have there been any major issues or concerns raised by your use of small buses?
(Please rank, with 1 = Most important reason. Please add any comments.)

[ ] Capital cost of vehicle _____
[ ] Customer acceptance _____
[ ] Maintenance costs _____
[ ] Operator acceptance _____
[ ] Safety _____
[ ] Vehicle reliability _____
[ ] Other? _____

Available Information on Small Bus Operations:

Do you track the operations/costs of the small bus operations separately? [ ] Yes [ ] No
Can you provide data on your small bus operations? *(Please check all that apply)*

[ ] Ridership [ ] Vehicle miles/hours [ ] Maintenance costs [ ] Fuel costs
[ ] Costs per vehicle hour/mile

Have you conducted any evaluations concerning your small bus operations? *(Please check all that apply)*

[ ] Customer acceptance [ ] Operator acceptance [ ] Maintenance acceptance
[ ] Ridership performance [ ] Financial evaluation [ ] Vehicle technology

Could you make the above information available for this study? [ ] Yes [ ] No

Small Bus Inventory

Please provide the following information on your small bus fleet (Please attach separate page if needed).

NUMBER	MANUFACTURER	MODEL	YEAR PURCH.

If you have any questions, please contact Rolland King at (614) 451-4195 or by E-mail at Tordking@aol.com.

When completed, please return this survey to:

E-mail: Tordking@aol.com
FAX: (614) 451-8189

or by mail: **Rolland King**
1266 Southport Circle
Columbus, OH 43235
U.S.A.

Thank you in advance for your cooperation and participation in this study.

USE OF SMALL BUSES IN TRANSIT SERVICE

TCRP SYNTHESIS TOPIC SB-6

QUESTIONNAIRE FOR TRANSIT AGENCIES NOT USING SMALL BUSES

*Purpose: The purpose of this study is to gather information on **the use of small buses in transit service**, as part of a Synthesis of Practice being prepared for the Transportation Research Board. All public transit services, open to the public, using small buses are of interest, such as fixed route, route deviation, demand responsive, etc. [Paratransit services exclusively available for eligible customers (i.e., ADA or Specialized Transit) are not included in the scope of this study.] For the purposes of this study, small buses are defined as vehicles used in public transit service that are thirty (30) foot or less in length.*

Transit Agency _____ Date _____

Address _____
(Street)

_____
(City) (State/Province) (Zip/Postal Code)

Contact Name _____ Title _____
Telephone _____ E-Mail _____
FAX _____

According to APTA's Vehicle Database, your agency does NOT operate small buses.

[ ] We do NOT operate any small buses.
[ ] We operate small buses. (No. of small buses operated: ____) *[Please return survey to address below]*

FOR TRANSIT SYSTEMS WHO DO NOT OPERATE SMALL BUSES

Have you ever considered operating small buses? [ ] Yes [ ] No

If yes, why did you choose not to purchase and operate small buses?
(Please rank, with 1 = Most important issue. Please add any comments.)
[ ] Capital cost of vehicle _____
[ ] Customer acceptance _____
[ ] Maintenance costs _____
[ ] Operator acceptance _____
[ ] Safety _____
[ ] Vehicle reliability _____
[ ] Other? _____

Would you reconsider the decision to purchase and implement small buses in the future?
[ ] No _____
[ ] Yes, but only under following conditions: _____

If you have any questions, please contact Rolland King at (614) 451-4195 or by E-mail at Tordking@aol.com. When completed, please return this survey to:

E-mail: **<Tordking@aol.com>**
FAX: **(614) 451-8189**

or by mail: **Rolland King**
1266 Southport Circle
Columbus, OH 43235
U.S.A

Thank you in advance for your cooperation and participation in this study.

USE OF SMALL BUSES IN TRANSIT SERVICE

TCRP SYNTHESIS TOPIC SB-6

(DRAFT) SMALL BUS MANUFACTURERS QUESTIONNAIRE

*Purpose: The purpose of this study is to gather information on **the use of small buses in transit service**. All open public transit services are of interest, such as fixed route, route deviation, and demand responsive. Paratransit services for restricted customer groups (i.e., ADA and Special Services) are not included in the scope of this study. For the purposes of this study small buses are defined as vehicles used in public transit service that are thirty (30) foot or less in length. The purpose of this survey is to gather information on the small buses that are available to transit agencies.*

Manufacturer _____ Date _____

Address _____
(Street)

_____
(City) (State/Province) (Zip/Postal Code)

Name of Contact _____

Telephone _____ FAX _____ E-Mail _____

Please provide the information requested in Table 2 on the following page for all of your small buses (30-foot or less) that are offered to transit agencies. Sales brochures that contain the requested information may be provided in lieu filling out the Table 2.

For each model defined in Table 2, please provide a cost range for the purchase of that bus model.

TABLE 1. Purchase Costs for Small Buses

BUS MODEL	Altoona Bus Testing (yes or no)	PURCHASE COST RANGE (do not include costs, such as spare parts, delivery costs, or training)

TABLE 2. Technical Description of Small Buses (30 foot or less)

MODEL IDENTIFICATION					
OVERALL LENGTH (ft)					
MAX. NO. OF PASS. SEATS					
APPROACH ANGLE (deg)					
DEPARTURE ANGLE (deg)					
BREAKOVER ANGLE (deg)					
MIN. TURNING RADIUS (ft)					
NUMBER OF PASS. DOORS					
ENTRANCE HEIGHT (in.) (unkneeled)					
EXIT HEIGHT (in.) (unkneeled)					
MAX. KNEELING CAPABILITY(in.)					
NUMBER OF STEPS TO ENTER OR EXIT BUS (e.g., 1, 2, or 3)					
EQUIPMENT FOR BOARDING WHEELCHAIRS (lift or ramp)					
GROSS VEHICLE WEIGHT RATING (GVWR in lbs)					
CURB WEIGHT (CW in lbs)					
PROPULSION OPTIONS **Internal Combustion (IC)** **Hybrid/Electric (HE) Fuel Cell (FC)** **Electric, battery (EB) Other ?**					
ENGINE (manufacturer & model)					
FUEL OPTIONS **Diesel (D) Gasoline (G) Ethanol (E)** **Compressed Natural Gas (CNG)** **Liquid Natural Gas (LNG)** **Propane (LNG) Other?**					
FUEL TANK CAPACITY (gal)					
TRANSMISSION (manufacturer & model)					
SERVICE LIFE (Use FTA vehicle categories: 4, 7, 10, & 12 years)					

If you have any questions, please contact Rolland King at (614) 451-4195 or E-mail at Tordking@aol.com. Please mail the completed questionnaire and other information to:

Rolland King
1266 Southport Circle
Columbus, OH 43235

or forward by FAX to (614) 451-8189 or by E-mail to Tordking@aol.com.

Thank you in advance for your time and cooperation by participating in this study.

APPENDIX B

Transit Agencies and Organizations That Participated in Study

Respondents to "User" Survey

AC Transit
Ann Arbor Transportation Authority
AppalCART
Area Transportation Authority of New Castle
Bay Metropolitan Transportation Authority
Birmingham–Jefferson County Transit
Blue Water Area Transportation
Calgary Transit
Cambria County Transit Authority
Capital Area Transportation Authority
Capital District Transportation Authority
Capital Metropolitan Transit Authority
Centre Area Transportation Authority
Champaign–Urbana Mass Transportation District
Charleston Area Regional Transportation Authority
Chatham Area Transit
Chula Vista Transit
Cities Utilities Transit
City Link–Abilene Transit System
City of Kalamazoo Metro Transit
City of Scottsdale
Connecticut Transit
Corner Brook Transit
Corpus Christi Regional Transportation Authority
C-TRAN–Vancouver
Department of Transportation Services–Honolulu
Edmonton Transit System
Fairfield/Suisun Transit
Foothill Transit
Fort Worth Transportation Authority
Grand Rapids Area Transit Authority
Greensboro Transit Authority
Indiana County Transit Authority
Kansas City Area Transportation Authority
King County Metro Transit Division
Knoxville Area Transit
La Crosse Municipal Transit
Lake Erie Transit
LAKETRAN
Lane Transit District
Lehigh and Northhamption Transportation Authority
Lethbridge Transit
Link Transit
Livermore/Amador Valley Transit Authority
London Transit Commission
LYNX
Manatee County Area Transit
Memphis Area Transit Authority
Metropolitan Atlanta Regional Transportation Authority
Mid-Ohio Valley Transit Authority
Minnesota Valley Transit Authority
Mississauga Transit
MTA Long Island Bus
New Castle Community Transit
Niagara Frontier Transportation Authority
Norwalk Transit District
Orange County Transportation Authority
PACE
Palm Beach County Transit
Pierce Transit
Port Arthur Transit
Port Authority of Allegheny County
Potomac & Rappahanock Transportation Commission
Regional Transportation District–Denver
Richmond Hill Transit
Riverside Transit
Sacramento Regional Transit District
Salem Area Mass Transit District
San Diego Metropolitan Transit
Santa Clara Valley Transportation Authority
Santa Clarita Transit
Santa Monica Big Blue Buses
Sarasota County Area Transit
Sault Ste. Marie Transit
Sioux Falls Transit
SMART
South Coast Area Transit
Spokane Transit Authority
STO Hull
SunLine Transit Agency
Tal Tran–Tallahassee
Terrebonne Parish Consolidated
The Transit Authority (Huntington, WV)
Toledo Area Regional Transit Authority
Transit Windsor
TransLink–Vancouver
Transportation Authority of Northern Kentucky
Tri-County Metropolitan Transportation
Valley Transit District
VIA Metropolitan Transit

Westchester County Department of Transportation
Westmoreland County Transit Authority
Winnipeg Transit System
York County Transportation Authority

Respondents to the "Non-Users" Survey

(Note: Some of the "non-user" survey respondents reported that they were in fact operating small buses.)

Belleville Ontario
Brampton Transit
Brandon Transit
Cape Breton Regional Transit Authority
City of Fairfax CUE Bus System
City of Glendale
City of North Bay Transit
City Ride–Ames Transit Agency
Clarksville Transit System
Community Action of Southern Kentucky
Community Action Transit System
Corporation Metropolitaine de Transport Sherbrooke
Delaware Area Transit Agency
East Chicago Transit
Eastern Contra Costa Transit Authority
Geauga County Transit
Glendale Beeline
Guam Mass Transit Authority
Guelph Transit
Halifax Regional Municipality Transit Services
Hamilton Street Railway
Island Transit
Kings Transit Authority
Kingston Transit
Loredo Municipal Transit
Louisiana Transit Company
Massachusetts Bay Transportation Authority
Medicine Hat Transit
Omnitrans
Peterborough Transit
Pickering Transit
Plymouth Metrolink
Pueblo Transit
Red Deer Transit
Regina Transit
Regional Transportation Commission
St. John Transit Commission
Sam Trans
Santa Barbara Metropolitan Transit District
Sarnia Transit
Societe de Transport Communaute Urvaine de Quebec
Societe de Transport de la Communaute Urbaine de Montreal
South Bend Public Transporation Corporation
Stratford Transit
Sudbury Transit
The Gulf Coast Center
Thunder Bay Transit
University of Massachusetts Transit
Waukesha Metro Transit
Whitby Transit
Windham Region Transit District
Yellow Knife Transit

Bus Manufacturers and Other Organizations

Advanced Bus Industries, LLC
Advanced Vehicle Systems, Inc.
Altoona Bus Testing Center
American Public Transportation Association
Blue Bird Corporation
Canadian Urban Transit Association
Champion Bus, Inc.
Chance Coach, Inc.
Diamond Coach Corporation
ElDorado–National
Gillig Corporation
Goshen Coach, Division of Warrick Industries
North American Bus Industries
Orion Bus Industries, Inc.
Starcraft Automotive Group
Thomas Dennis Company, LLC

APPENDIX C

Small Bus Fleets of the "User" Survey Respondents

TRANSIT AGENCY	MANUFACTURER and MODEL	NUMBER
AC Transit	ElDorado–National—Aerotech	31
Ann Arbor Transportation Authority	Orion Bus Industries—Orion II	2
AppalCART (Boone, NC)	Blue Bird Bus—30-Foot	5
	ElDorado–National—Aerotech	4
	Dodge—van conversion	8
Area Transportation Authority of New Castle	Orion Bus Industries—Orion II	41
	Chance Coach—RT 52	7
	New Flyer Industries—D30L	3
	Gillig—Phantom	1
Bay Metropolitan Transportation Authority	Thomas Built Bus—BB 25-Foot	5
	ElDorado–National—ELF	1
	Ford—van	12
	Orion Bus Industries—Orion 1	7
	Orion Bus Industries—Orion II	26
Birmingham–Jefferson County Transit	ElDorado–National—24 AX	4
	Advanced Vehicle Systems—AVS-22	2
Blue Water Area Transportation	Orion Bus Industries—Orion V	4
	Orion Bus Industries—Orion II	15
	Diamond—cut-a-way	3
Calgary Transit	Blue Bird Bus—E37	2
	Thomas Built Bus—Baby Vista	25
	Goshen Coach—GC II	31
	Orion Bus Industries—Orion II	1
	ElDorado–National—ELF	1
Cambria County Transit Authority	Champion Motor Coach—Contender	10
	Flxible—Metro 30	5
	Orion Bus Industries—Orion II	2
	Chance Coach—RT 52	2
	Ford—cut-a-way	17
Capital Area Transportation Authority	Champion Motor Coach—Challenger	40
Capital District Transportation Authority	Ford—22-Foot	22
	Ford—26-Foot	5
	Orion Bus Industries—Orion II	27
	Dodge—van	2
Capital Metropolitan Transit Authority	New Flyer Industries—D30LF	80
Centre Area Transportation Authority	Coach and Equipment—Phoenix	6
Champaign–Urbana Mass Transit District	ElDorado–National—ELF 125	3
	Dodge—RAM van	3
	Dodge—Caravan	3
Charleston Area Regional Transportation Authority	Goshen Coach—Pacer	1
Chatham Area Transit	Gillig—Phantom	4
	Goshen Coach—GC II	4
Chula Vista Transit	Goshen Coach—Sentry	4
Cities Utilities Transit	New Flyer Industries—D30L	23
City Link–Abilene Transit System	Chance Coach—RT 52	13
City of Kalamazoo Metro Transit	Flxible—Metro 30	6
	ElDorado–National—E-Z Rider	8
City of Scottsdale	Blue Bird Bus—CS	7
	ElDorado–National—Transmark	3
Connecticut Transit	ElDorado–National—E-Z Rider	13
Corner Brook Transit	Blue Bird Bus—MBIV	6
	Thomas Built Bus—Vista Cruise	1
Corpus Christi Regional Transportation Authority	ElDorado–National—Transmark RE	10
	Chance Coach—RT 52	3

TRANSIT AGENCY	MANUFACTURER and MODEL	NUMBER
C-TRAN–Vancouver	ElDorado–National—Aerotech	43
	Gillig—Phantom	25
	Collins Bus—Diplomat	7
Department of Transportation Services–Honolulu	Gillig—Phantom	10
Edmonton Transit System	ElDorado–National—ELF 125	19
Fairfield/Suisun Transit	Gillig—Phantom	18
	Wide One—Wild One	3
	Collins Bus—Royale 1600	2
	Plymouth—Caravan	2
Foothill Transit	Gillig—Spirit	7
Fort Worth Transportation Authority	Champion Motor Coach—Centurion 25-Foot	12
	ElDorado–National—Aerotech	5
	World Trans—3000	20
Grand Rapids Area Transit Authority	Gillig—Phantom	12
Greensboro Transit Authority	Thomas Built Bus—BB 25-Foot	5
	Ford—van	11
	ElDorado–National—Aerotech	6
	Dodge—van	4
Indiana County Transit Authority	New Flyer Industries—C30L	3
	ElDorado–National—Escort	2
	Collins Bus—Diplomat	1
	Champion Motor Coach—CTS	1
	Thomas Built Bus—Scat	1
	ElDorado–National—Transmark	1
	Coach and Equipment—PHOENIX	6
Kansas City Area Transportation Authority	ElDorado–National—Transmark	32
	Gillig—Phantom	53
	Goshen Coach—GC II	12
	ElDorado–National—Aerotech	23
King County Metro Transit Division	Gillig—Phantom	95
	Champion Motor Coach—Challenger	42
Knoxville Area Transit	ElDorado–National—Escort II	13
	Flxible—Metro 30	9
La Crosse Municipal Transit	Flxible—Metro 30	6
Lake Erie Transit	Champion Motor Coach—Centurion	25
LAKETRAN	Goshen Coach—Pacer	27
	Goshen Coach—Sentry 1290	1
	ElDorado–National—Aerotech	19
	Supreme—BS 22	14
Lane Transit District	Gillig—Phantom	6
Lehigh and Northhampton Transportation Authority	Orion Bus Industries—Orion II	13
Lethbridge Transit	ElDorado–National—ELF 125	1
Link Transit	World Trans–Diplomat	14
	Goshen Coach—GC II	12
	Orion Bus Industries—Orion II	1
	Orion Bus Industries—Orion 1	20
	ElDorado–National—Aerotech	3
Livermore/Amador Valley Transit Authority	Chrysler—mini-van	3
	ElDorado–National—Aerotech	12
	Collins Bus—unknown	2
London Transit Commission	Orion Bus Industries—Orion II	14
LYNX	Orion Bus Industries—Orion V	26
Manatee County Area Transit	Gillig—Phantom	14
	Supreme—Star Trans	12
	Thomas Built Bus—BB	7
Memphis Area Transit Authority	ElDorado–National—ELF 125	29
	Champion Motor Coach—SoLo	14
	Dodge—Caravan	7
Metropolitan Atlanta Regional Transit Authority	New Flyer Industries—C30LF	22
Mid-Ohio Valley Transit Authority	Advanced Bus Industries—TSV-25	4
Minnesota Valley Transit Authority	Metrotrans—Legacy	5
	Supreme—Startrans Senator	6

TRANSIT AGENCY	MANUFACTURER and MODEL	NUMBER
Mississauga Transit	Orion Bus Industries—Orion II	12
MTA Long Island Bus	Orion Bus Industries—Orion II	5
	Coach and Equipment—PHOENIX	7
New Castle Community Transit	Supreme—Startrans	4
	Diamond—VIP	2
Niagara Frontier Transportation Authority	Orion Bus Industries—Orion 1	2
Norwalk Transit District	Goshen Coach—GC II	13
	Goshen Coach—Pacer	2
	ElDorado–National—E-Z Rider	1
	Turtle Top—CP30	4
Orange County Transportation Authority	ElDorado–National—ELF	24
	ElDorado–National—E-Z Rider	25
PACE	ElDorado–National—Transmark RE-29	56
	Chance Coach—RT 52	18
	ElDorado–National—Escort II	60
Palm Beach County Transit	Chance Coach—RT 52	42
Pierce Transit	ElDorado–National—MST	3
	ElDorado–National—Aerotech	74
	Dodge—Maxivan	7
Port Arthur Transit	Orion Bus Industries—Orion 1	10
Port Authority of Allegheny County	World Trans—Mid Bus	80
Potomac & Rappahanock Transportation Commission	Supreme—Startrans	22
Regional Transit District–Denver	Gillig—Phantom	81
	ElDorado–National—Transmark RE	45
	Goshen Coach—GC II	58
	World Trans—WT 3000	27
	Metrotrans—Classic	14
	Braun—Extension	30
	ElDorado–National—Escort II	46
	Dodge—RAM van	44
	Care Concepts—Transporter	30
Richmond Hill Transit	Orion Bus Industries—Orion V	4
	Orion Bus Industries—Orion II	2
	Champion Motor Coach—SoLo	3
Riverside Transit	ElDorado–National—E-Z Rider	3
	World Trans—Grand Commuter	33
	Collins Bus—Diplomat	3
	Supreme—Senator	6
	ElDorado—National—Aerotech	11
	Goshen Coach—GC II	8
	Collins Bus—Super Bantum	9
Sacramento Regional Transit District	Orion Bus Industries—Orion V	15
Salem Area Mass Transit District	ElDorado–National—E-Z Rider	10
San Diego Metropolitan Transit	ElDorado–National—Aerotech	22
Santa Clara Valley Transportation Authority	Flxible—Metro 30	40
Santa Clarita Transit	Gillig—Spirit	11
	ElDorado–National—Aerotech	11
	World Trans—Diplomat	2
Santa Monica Big Blue Buses	APS Systems—26-Foot	4
Sarasota County Area Transit	Orion Bus Industries—Orion 1	13
	Champion Motor Coach—Challenger	2
Sault Ste. Marie Transit	Ford—unknown	2
Sioux Falls Transit	Gillig—Phantom	17
	NovaBus—RTS 30	8
SMART	Champion Motor Coach—Centurion	108
	Champion Motor Coach—Challenger	154
	ElDorado–National—Aerotech	149
	Gillig—Phantom	22
South Coast Area Transit	Ford—cut-a-way	12
	Flxible—Metro 30	2
	Orion Bus Industries—Orion V	9
Spokane Transit Authority	Flxible—Metro 30	6
STO Hull	Orion Bus Industries—Orion II	4

TRANSIT AGENCY	MANUFACTURER and MODEL	NUMBER
SunLine Transit Agency	ElDorado–National—Escort 29	5
	Specialty Vehicles—25-Foot	3
Tal Tran—Tallahassee	Orion Bus Industries—Orion II	5
Terrebonne Parish Consolidated	ElDorado–National—E-Z Rider	8
The Transit Authority (Huntington, WV)	Ford—van	10
Toledo Area Regional Transit Authority	ElDorado–National—RVC 22-Foot	5
	ElDorado–National—Aerotech	1
	Coach and Equipment—Phoenix	6
	Flxible—Metro 30	25
	Supreme—35C 24-Foot	9
Transit Windsor	Orion Bus Industries—Orion II	2
	Girardin—MBC	10
TransLink—Vancouver	Ford—Polar	22
	ElDorado–National—ELF	2
	Ford—Prof Comp	163
Transportation Authority of Northern Kentucky	Orion Bus Industries—Orion II	18
	Supreme—Startrans	12
	Dodge—Caravan	3
Tri-County Metropolitan Transportation	Gillig—Phantom	43
	Flxible—Metro 30	10
	ElDorado–National—Aerotech	10
	Collins Bus—3000	18
Valley Transit District	Goshen Coach—GC II	6
	Chance Coach—Diplomat	8
	Champion Motor Coach—Commander	2
VIA Metropolitan Transit	Chance Coach—RT 52	15
	Champion Motor Coach—SoLo	66
Westchester County Department of Transportation	Supreme—Metrotrans	48
Westmoreland County Transit Authority	Coach and Equipment—PHOENIX	3
	Supreme—Senator	2
Winnipeg Transit System	New Flyer Industries—D30L	15
	Orion Bus Industries—Orion 1	22
York County Transportation Authority	Orion Bus Industries—Orion 1	6
	Chance Coach—RT 52	2
	Champion Motor Coach—CTS	4
	Diamond—MINIBUS	1
	Coach and Equipment—PHOENIX	11

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